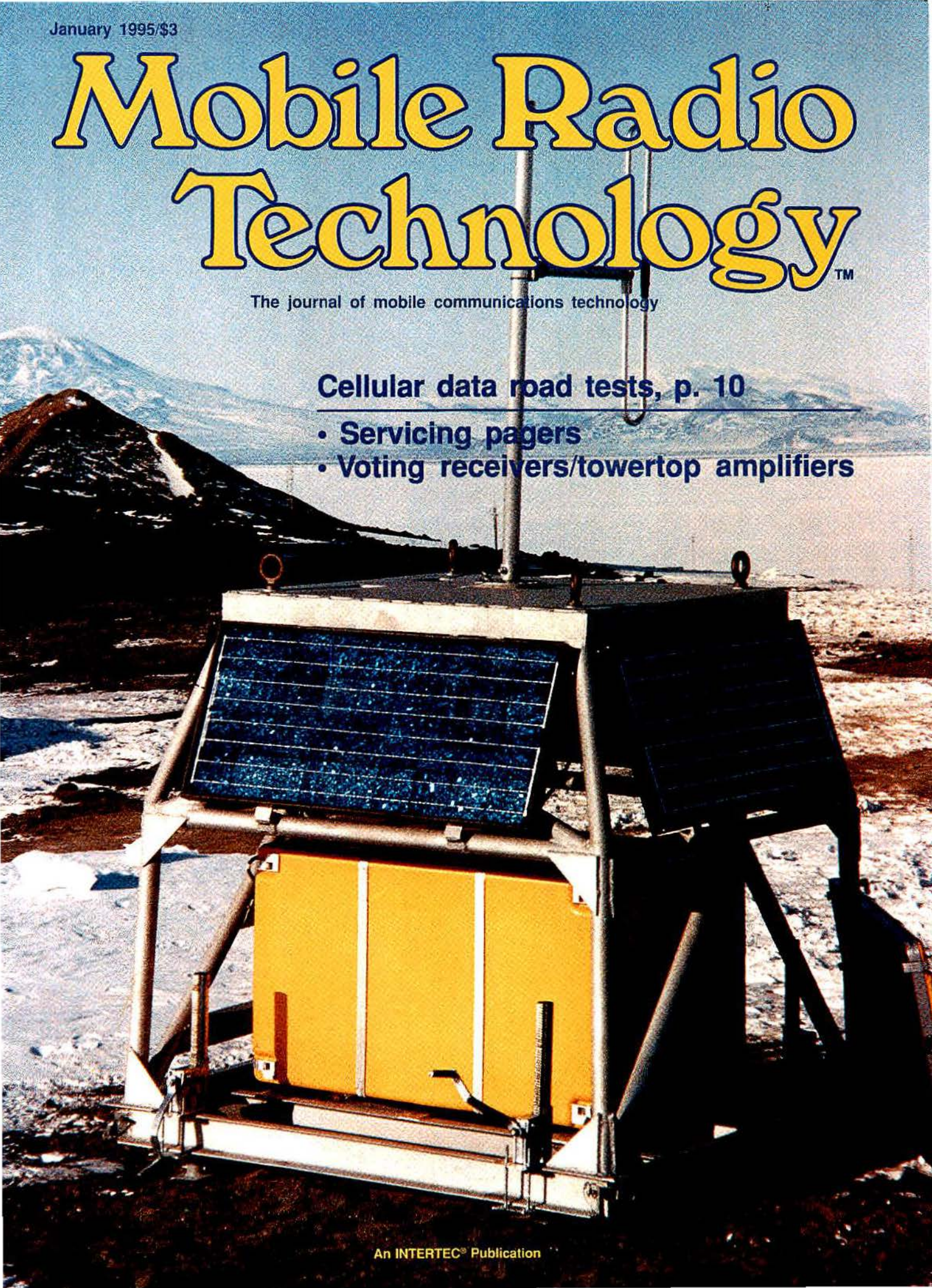
January 1995/$3

Mobile Radio Technology™

The journal of mobile communications technology

Cellular data road tests, p. 10

- Servicing pagers
- Voting receivers/towertop amplifiers



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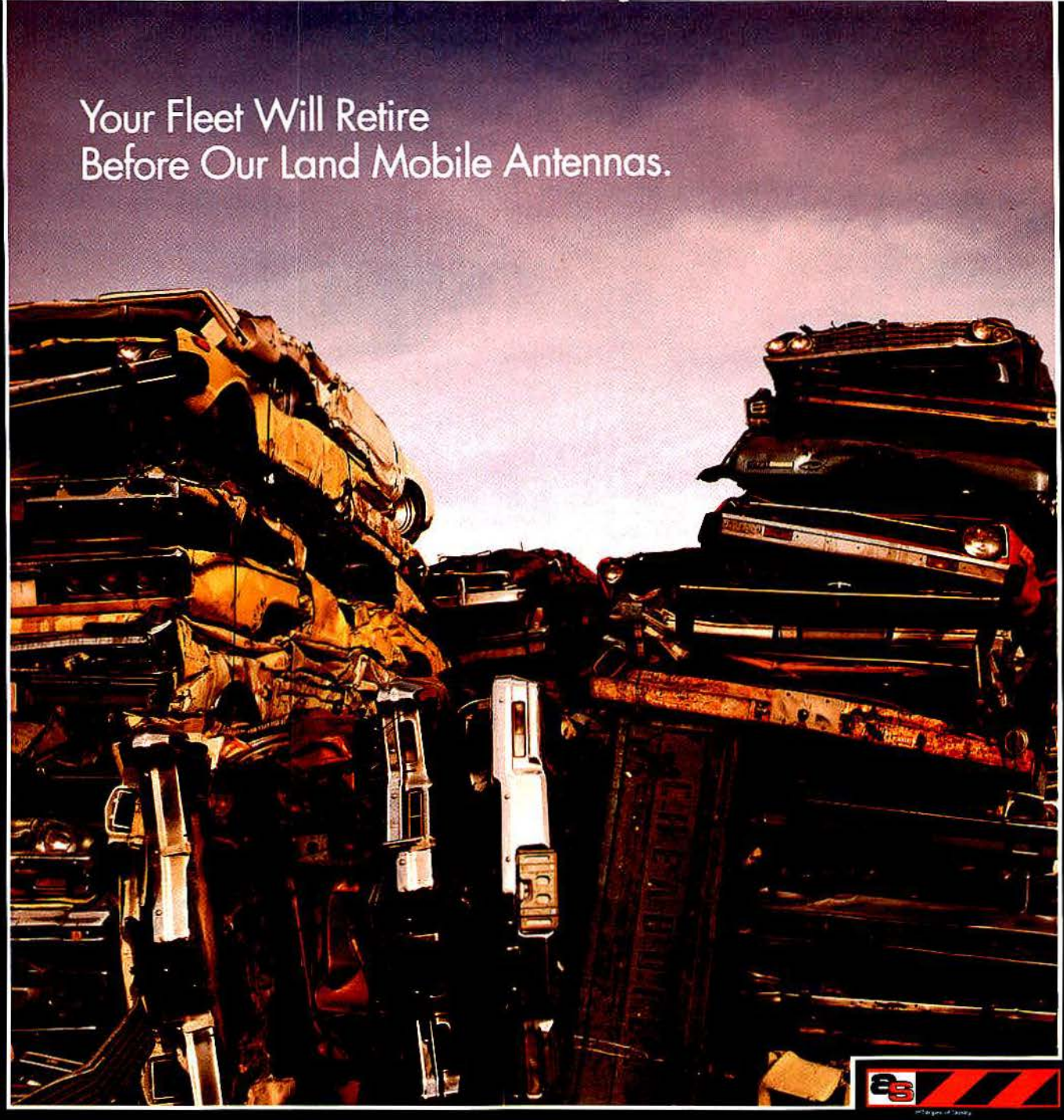

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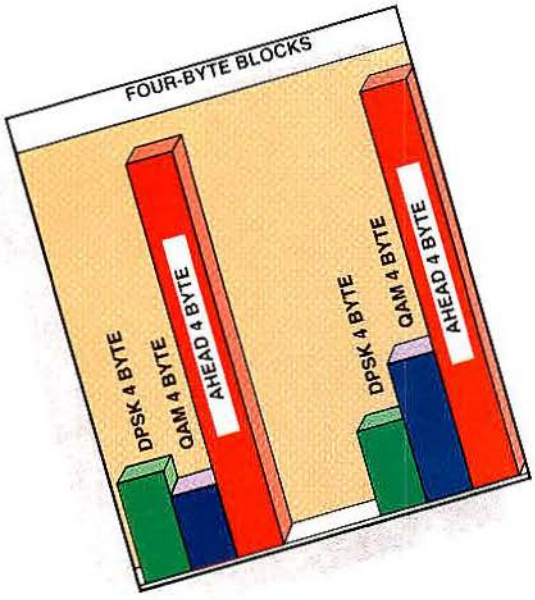

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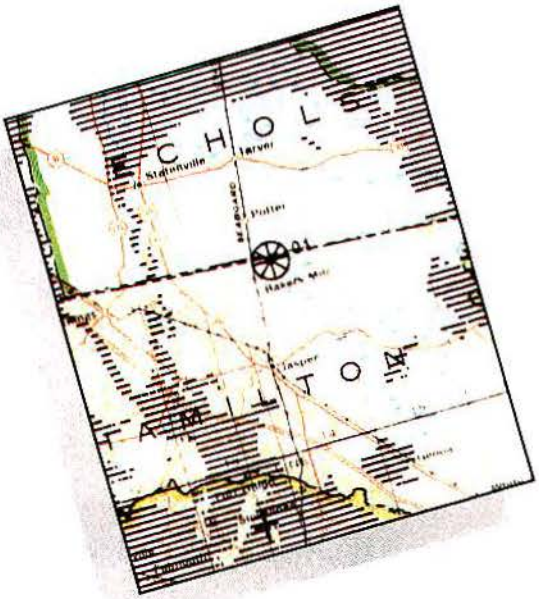

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40 Using voting receivers and towertop amplifiers
Gordon F. Sargent, P.E., D.E.
Whether to use voting receivers or towertop amplifiers to improve radio coverage may depend on terrain, site noise and the presence of strong unwanted signals at the repeater site, among other factors.

On the cover: This portable VHF repeater is pictured as it was made ready for transport to Mount Discovery, which appears to its left in the background. As installed, the repeater covers the area around McMurdo, Antarctica, 42 miles from Mount Discovery, with a range of about 100 miles at 140MHz. The yellow box houses the electronics and four 90Ah batteries. Solar cells cover all four sides. The sun shines 24 hours a day during summer in Antarctica, which keeps the batteries fully charged. *Photo courtesy of Bill Robertson: Naval Command, Control and Oceanic surveillance Center, ISE: Charlotte, NC.*

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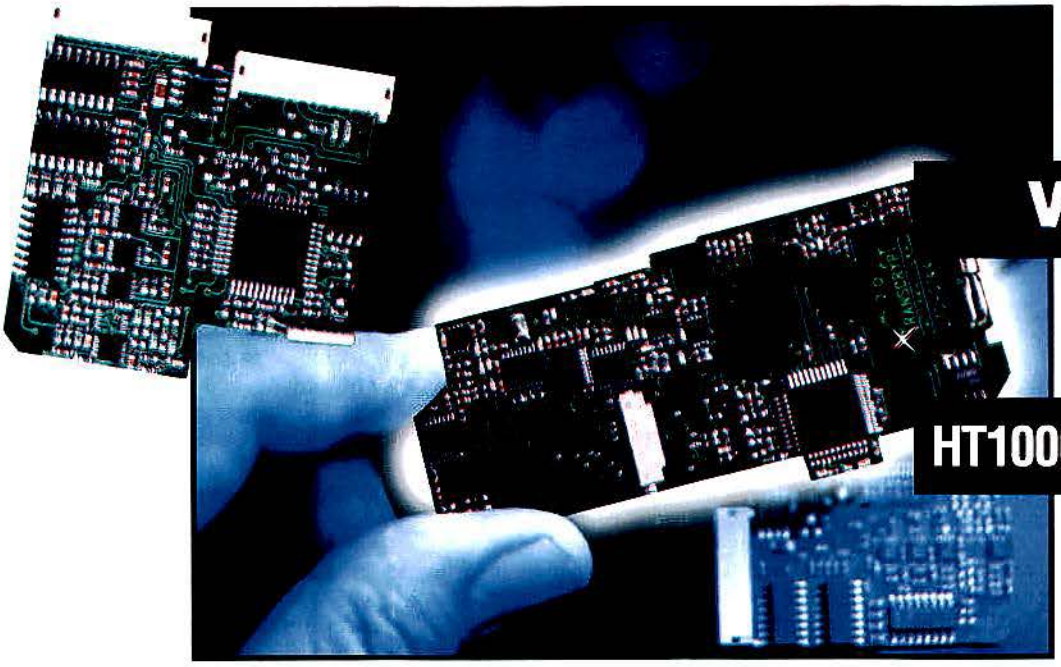

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Expansion for small SMR systems and private communications networks depends on Congress

As a result of the November 1994 election, Republicans now outnumber Democrats in both houses of Congress. Although this change is dramatic at a political level, will it improve the prospects for small businesses that provide radio communications services? Not without a good deal of effort to persuade the new Congress to pass supplemental legislation.

Some of the affected businesses include radio communications equipment dealerships, community and private carrier repeater operators, and specialized mobile radio (SMR) system operators.

Also affected are private communications network (PCN) operators (excluding state and local governments): commercial and industrial businesses that operate their own radio communications systems, such as utilities, motor carriers, manufacturers, farmers, miners and ranchers.

Auctions, common carriers

Two big changes in radio communications regulation made during the past two years work to the disadvantage of small businesses. One is the use of auctions to allocate radio frequency spectrum. Competitive bidding makes new channels too expensive for many small businesses to acquire. The other is a reclassification of many former private radio facilities as common carrier facilities. Common carrier regulation is an expensive burden that many small businesses are incapable of bearing.

Along with these long-term changes came an Aug. 8, 1994, FCC moratorium (a "freeze") on processing pending SMR license applications or accepting new ones. At one point, the commission seemed prepared to dismiss more than 40,000 pending applications and to auction the remaining SMR frequencies. The freeze imposed yet another burden on small businesses that had invested money in expansion plans. The FCC ultimately was persuaded to process the pending applications, but it remains to be seen whether the commission will accept future SMR applications without competitive bidding.

Donation spurs action

In late November, the FCC accepted an offer by a coalition of trade associations to donate $20,000 worth of computer software services, training and support to process the pending applications by Feb. 28. We're glad that the pending applications will be processed. Small businesses that filed applications in good faith to expand their existing radio systems may receive licenses as a result, although many licenses will go to speculators. At the same time, it is ludicrous that a federal agency that has auctioned $1 billion worth of spectrum in recent months should have to be prodded into acting on SMR license applications by a donation.

Once these applications have been processed, small SMR and PCN operators still will face the prospect of auctions, and small SMR operators will face, in addition, common carrier regulation. Some small SMR operators may discontinue interconnection service (discontinue offering mobile telephone service), a step that would avoid common carrier regulation. Without interconnection, their service would be limited to dispatching (communication within the radio network).

The public good

After the pending applications are processed, to obtain licenses for additional frequencies without buying them at auction, small SMR and PCN operators must persuade the new Congress to exempt their applications from competitive bidding—no small task. They must prove that it is for the public good to give spectrum to small SMRs and PCN operators—better than selling the spectrum to "super-SMRs" and better than forcing PCN operators to buy services from "super-SMRs," cellular telephone carriers or personal communications service companies rather than use their own networks.

The small SMR and PCN operators must prove that distributing spectrum by auction harms SMR users and PCN operators. Without competition from small SMRs and private network suppliers, the limited number of large carriers will be free to charge higher prices than they otherwise might to recover their spectrum investments. What the public gains in auction revenue it could lose in communications services costs. These costs would be paid directly by users to carriers or indirectly as part of the cost of products made by companies that pass along their own communications services costs.

Safety is an important issue, too. Many PCNs are designed with specific coverage areas and capabilities that are unequalled by SMR, cellular, paging and proposed personal communications service carriers. Workers in utility companies, mines, farms, factories and other enterprises could be placed at greater risk without proper radio communications.

Change brings opportunity

The change from Democrat to Republican leadership in Congress may make it difficult to initiate the necessary legislation. Committee and subcommittee chairmanships will change, and the staff is scheduled to be reduced by one-third. Significantly, House committee and subcommittee with responsibility for telecommunications legislation are on the new leadership's list of committees to be discontinued, with those responsibilities to be assigned to other existing committees.

The matter of expanding small SMRs and PCNs seems to be entirely out of the hands of the FCC. According to public statements by FCC officials, no more spectrum will be allocated for private communications networks. One official recommended that small SMRs bid for personal communications services spectrum to use in expanding their capacity and coverage because no additional SMR licenses will be available to them, either. With that kind of flat rejection, based on the current direction from Congress, small SMRs and PCN operators will have to make the most of the opportunity that the change in Congress will bring to ensure a supply of radio frequency spectrum.

—Don Bishop

Calendar

January

18-20—Mobile Communications Conference, sponsored by Frost & Sullivan, Westin Hotel, Galleria Dallas, Dallas. Contact: 800-256-1076.

February

1-3—Cellular Telecommunications Industry Association Winter Meeting and Exposition, New Orleans. Contact: 202-785-0081.

March

13-14—AMTEX, the American Mobile Telecommunications Association's Marketing and Technology Conference and Exposition, The Buttes, Tempe, AZ. Contact: 202-331-7773.

16-17—Government Land Mobile Communications Conference, sponsored by TMSA Conferences, Rosslyn Westpark Hotel, Arlington, VA. Contact: Steven Silver, 310-534-4871.

20-23—Supercomm, sponsored by USTA and TIA, Anaheim Convention Center, Anaheim, CA. Contact: 202-326-7300.

April

3-5—Energy Telecommunications and Electrical Association, George R. Brown Convention Center, Houston. Contact: 214-235-0655.

12-13—Wireless Business Telephone Systems, sponsored by Alexander Resources, Bristol Suites Hotel, Dallas. Contact: Carole Kaufman, 800-948-8225.

25-27—International Wireless Communications Expo/Spring, Las Vegas Sands Convention Center, Las Vegas. Contact: 800-828-0420.

May

17-19—Mobile Communications Conference, sponsored by the Personal Communications Industry Association (PCIA), Hotel del Coronado, San Diego. Contact: Nancy Palleschi, 800-759-0300.

31-June 2—Radiocomm, Toronto Metropolitan Convention Center, Toronto. Contact: 613-233-4888.

July

26-28—Vehicular Technology Conference, sponsored by IEEE Vehicular Technology Society, Hyatt Regency Chicago O'Hare, Chicago. Contact: Keith Paglusch, chairman, 312-399-2378.

31-Aug. 4—Utilities Telecommunications Council, Hyatt Regency and Convention Center, Minneapolis. Contact: 202-872-0030.

August

13-18—Association of Public-Safety Communications Officials—International National Conference, Detroit. Contact: 800-949-2726.

September

20-23—Personal Communications Showcase, sponsored by the Personal Communications Industry Association (PCIA), Orange County Convention Center, Orlando, FL. Contact: 800-326-8638.

October

18-20—International Wireless Communications Expo/Fall, Tampa Convention Center, Tampa, FL. Contact: 800-828-0420.

26—ERA Communications Trade Fair, Ala Moana Hotel, Honolulu. Contact: 310-287-1218.

November

7-9—WirelessWorld Conference and Exposition, sponsored by *Cellular Business* and *Mobile Radio Technology* magazines, Moscone Convention Center, San Francisco. Contact: Chris Lotesto, 800-458-0479.

8-12—Communications Marketing Conference, sponsored by the Communications Marketing Association, Albuquerque, NM. Contact: Bernie Brownson, 303-371-8182.

17—Radio Club of America, Communications Symposium, 86th Anniversary Dinner and Awards Presentation, New York Athletic Club, New York. Contact: Ron Formella, 201-652-6811.

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The journal of mobile communications technology

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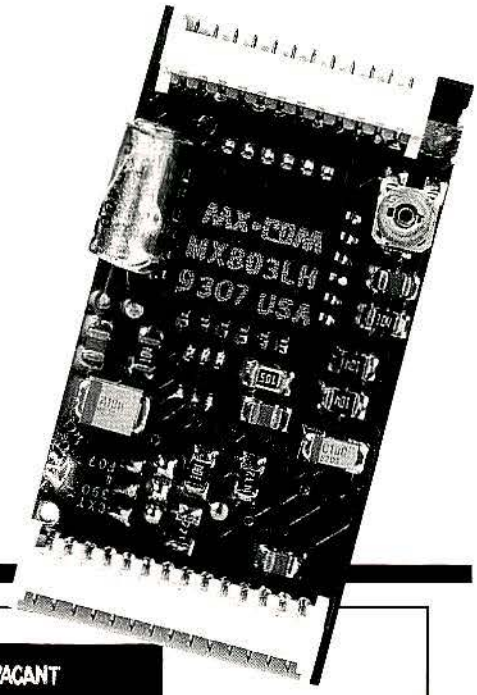

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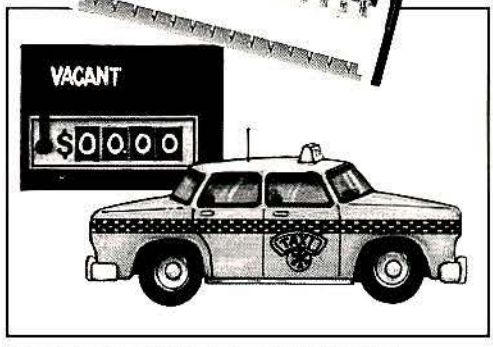

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Modulation acceptance bandwidth

By Harold Kinley, C.E.T.

The specifications on an FM communications receiver usually specify a figure for *modulation acceptance bandwidth*. What is modulation acceptance bandwidth, and what is the significance of the specification figure? We will attempt to answer that question and maybe raise some new ones.

IEEE definition

The Institute of Electrical & Electronics Engineers (IEEE) defines modulation acceptance bandwidth as:

> The selectivity characteristic of a receiver that limits the maximum permissible modulation deviation of the radio-frequency input signal that a receiver can accept, without degradation of the 12-decibel SINAD, when the radio-frequency input signal is 6 decibels greater then the reference sensitivity level. (page 4, IEEE publication standard 184-1969, *IEEE Test Procedure for Frequency-Modulated Mobile Communications Receivers.*)

Test procedure

The setup for the test procedure is shown in Figure 1 below. This is the same test procedure setup that is used to determine the 12dB SINAD sensitivity of a receiver. To determine a receiver's modulation acceptance bandwidth, first perform

(continued on page 45)

Kinley, a certified electronics technician, is regional communications manager, South Carolina Forestry Commission, Spartanburg, SC. He is the author of *Standard Radio Communications Manual: With Instrumentation and Testing Techniques*, Prentice-Hall, 1985. He is a member of the Radio Club of America.

Figure 1. The setup for measuring modulation acceptance bandwidth.

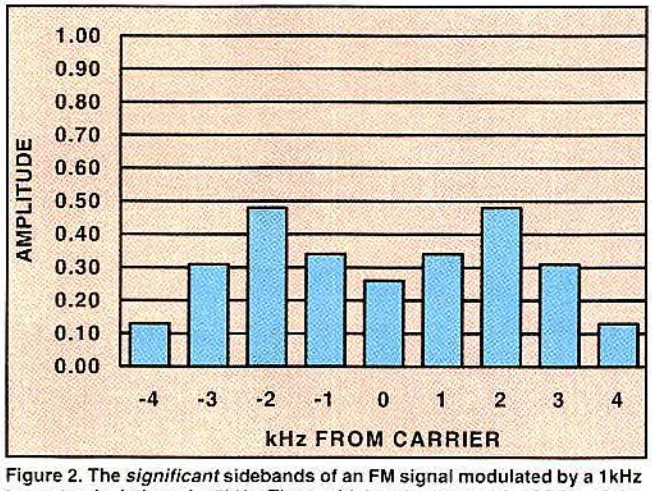

Figure 2. The *significant* sidebands of an FM signal modulated by a 1kHz tone at a deviation of ±3kHz. These sidebands account for 99.6% of the power in the sideband spectrum. Modulation index (β) = 3.

Table 1—The Bessel functions of the *significant* sidebands for modulation indice (β) of 3, 5 and 7.

COMPONENT	AMPLITUDE		
	β = 3	β = 5	β = 7
J_0 (β)	0.2601	0.1776	0.3001
J_1 (β)	0.3391	0.3276	0.004863
J_2 (β)	0.4861	0.04657	0.3014
J_3 (β)	0.3091	0.3648	0.1676
J_4 (β)	0.1320	0.3912	0.1578
J_5 (β)	- - - -	0.2611	0.3479
J_6 (β)	- - - -	0.1310	0.3392
J_7 (β)	- - - -	- - - -	0.2336
J_8 (β)	- - - -	- - - -	0.1280

β = MODULATION INDEX
J_0 = CARRIER
J_1 = 1ST SIDEBAND PAIR
J_n = nTH SIDEBAND PAIR

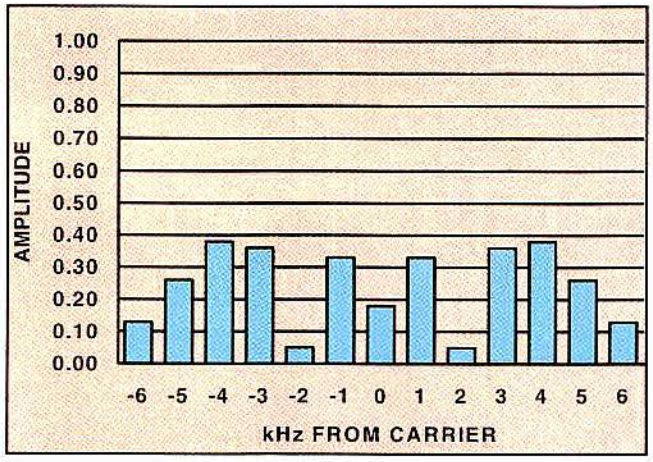

Figure 3. The *significant* sidebands of an FM signal modulated by a 1kHz tone at a deviation of ±5kHz. These sidebands account for 99.3% of the power in the sideband spectrum. Modulation index (β) = 5.

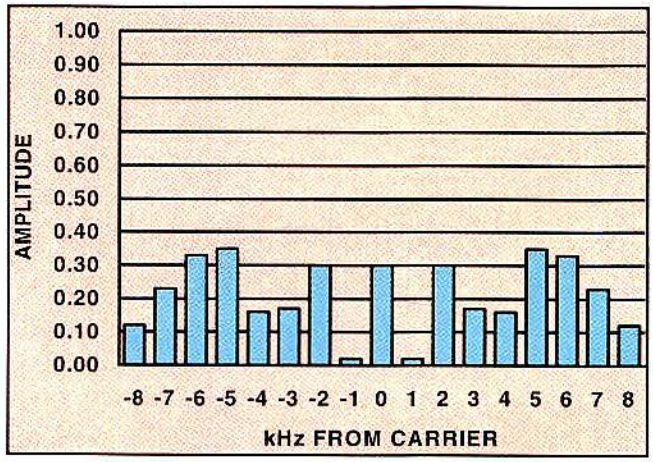

Figure 4. The *significant* sidebands of an FM signal modulated by a 1kHz tone at a deviation of ±7kHz. These sidebands account for 99.2% of the power in the sideband spectrum. Modulation index (β) = 7.

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- Each memory location can have different CTCSS and/or DCS for encode or decode
- Emergency ANI with repeat delay timer
- Accidental "man down" warning tone timer
- High-pass filter for removing tones from receive audio signal

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- Encodes 38 standard CTCSS & 13 split tones
- Programmable custom CTCSS, and DCS codes
- Each memory location can have different CTCSS and/or DCS for encode or decode
- Encodes Burst tone with programmable frequency & timing
- Emergency ANI with repeat delay timer
- Accidental "man down" warning tone timer
- Field-selectable positive and negative squelch output
- CTCSS can be held off before and during ANI
- CTCSS modulation is programmable relative to ANI

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- Available with optional small 15 turn trim pot to reduce thickness

Decode features:

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- Wide dynamic input range
- Positive or negative squelch output
- High pass filter removes CTCSS and DCS tone from receiver audio

10 ♦ MODEL TCS-3

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Circle (8) on Fast Fact Card

Cellular data 'road tests' of modulation technologies

Comparison tests on two cellular systems with DPSK, QAM and AHEAD modulation technologies show AHEAD to offer superior throughput rates and error performance. Vehicle speed had little effect on data throughput.

By Herbert R. Perkins

Dominant voiceband modulation technologies include differential phase-shift keying (DPSK) and quadrature amplitude modulation (QAM). A new technology, asynchronous halfwave encoding and decoding (AHEAD), has become available during the past year. (See "Modem Speeds Throughput for Data Sent by Any Radio" by Dr. Rainald Schoneberg, July 1993 *Mobile Radio Technology*.)

These three technologies, DPSK, QAM and AHEAD, were tested in real-world land mobile cellular applications to determine actual performance over voiceband systems with moving vehicles.

In more than 300 cellular hours of on-the-road mobile testing, DPSK and QAM throughputs were about 440 bits per second (bps) and 1,920bps, respectively. Frequent and extended blackout periods were experienced while the modems tried to recover. Calls were often dropped by the modems. In contrast, AHEAD, an enhanced frequency-shift keying-related modulation technology, proves to be three to 12 times better, depending on the modulation method it is compared against. When compression schemes such as MNP-10 or V.42bis are used as a basis for comparison between modulation methods, the difference between AHEAD, DPSK and QAM becomes 10 to 30 times in favor of AHEAD.

Modem

The word *modem* is a contraction of *mo*dulator-*dem*odulator. A modulator converts digital data to an analog carrier for transmission over a land mobile radio network. A demodulator receives the analog carrier and recovers the digital data.

Several techniques of encoding data into an analog carrier (frequency, phase and amplitude) at higher speeds are known: DPSK, QAM and AHEAD.

Commercially available voiceband modems differ in features, implementations and performance when used over land mobile and cellular radio networks. All use one of the three encoding techniques listed above that result in specific waveforms; therefore, no matter how a DPSK, QAM or AHEAD system is implemented or what type of software is added to improve the performance, all technologies are limited by the network's effects on the waveform.

Compression, coding and similar operations performed on the data are independent of the modulation technology.

To determine which modulation technology (waveform) is best suited for land mobile and cellular radio networks, tests have been designed and performed that compare DPSK, QAM and AHEAD waveforms in voiceband cellular networks.

Summaries of the tests provide valuable information to users and operators of voiceband land mobile radio and cellular systems.

Background information

Cellular networks — A cellular system is an FM radio network composed of several base stations that cover a geographical area, inside of which cellular telephones can operate. These stations are managed and controlled by (distributed) digital switch equipment known as the *mobile*

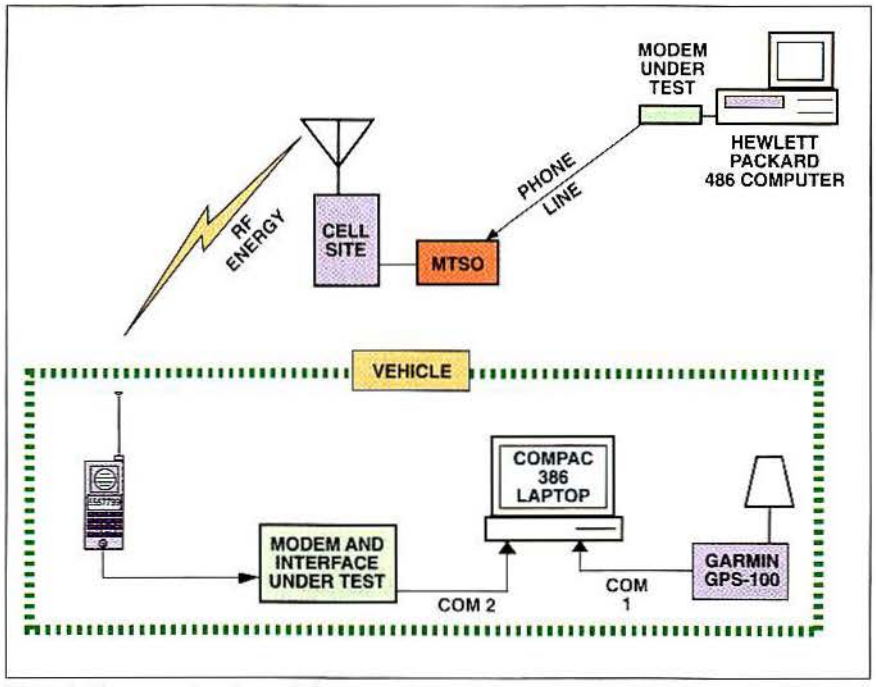
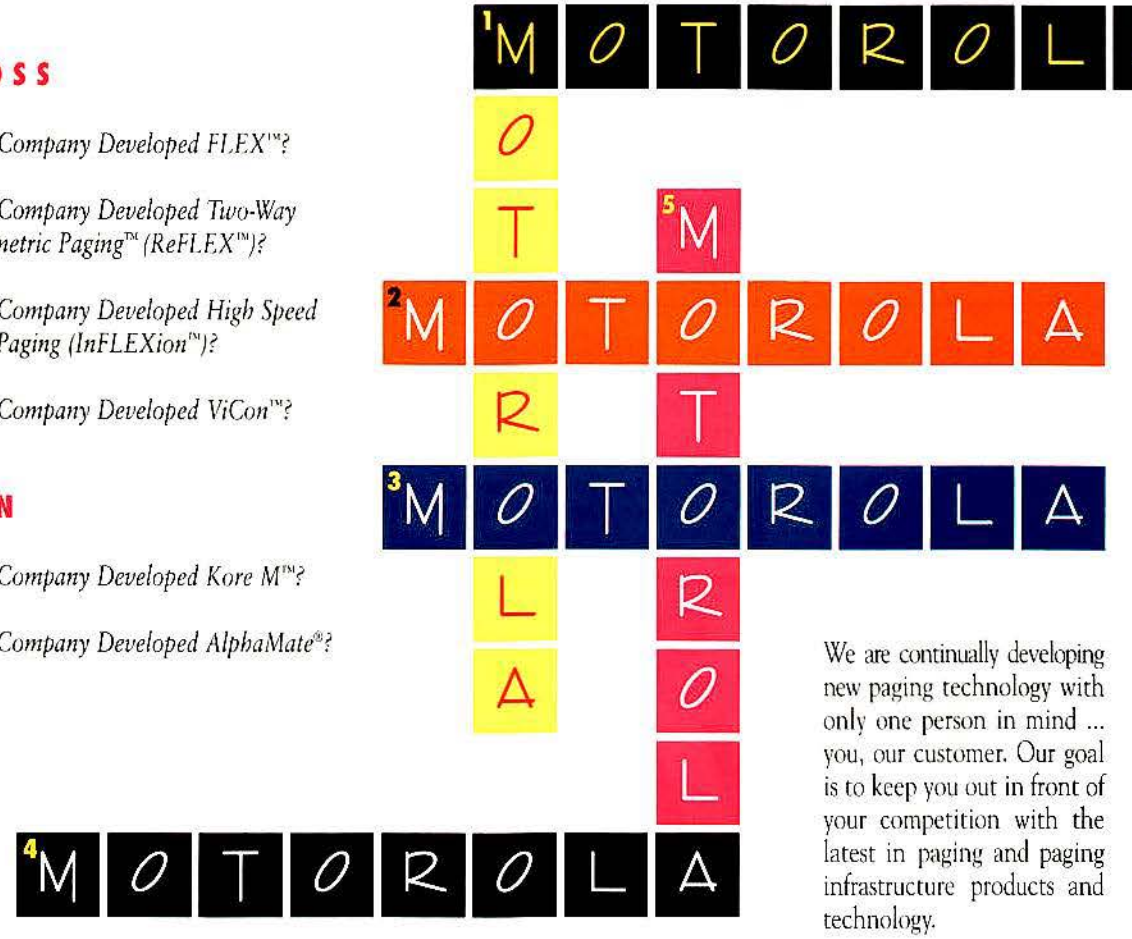


Figure 1. The test set up is as plain as possible, with nothing unique about the hardware.

Perkins lives in Longwood, FL.

When It Comes To Paging Technology, Only One Name Solves The Puzzle.



ACROSS

1 *What Company Developed FLEX™?*

2 *What Company Developed Two-Way Asymmetric Paging™ (ReFLEX™)?*

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Table 1—Equipment used for the test had several variations.

EQUIPMENT TYPE	EQUIPMENT DETAIL
Modems	a) Microporte 4232BIS 14,400bps b) Intel SatisFAXtion 400e 14,400bps c) AHEAD
Cellular Phones (hand-held)	a) OKI 1150 b) Motorola Flip Phone c) Ericsson
Interface	a) RJ-11 for Motorola Flip Phone b) Hands-free option for Motorola Flip Phone c) Hands-free option for Ericsson
Computers	a) 386 Compaq Contura laptop b) 486 Hewlett Packard
GPS	Garmin GPS-100
Vehicle	Jeep with soft top

telephone switching office (MTSO). A base station is known as a cell site and is composed of low-power FM transceivers, power amplifiers, control units and antennas. Its function is to interface cellular mobiles and the MTSO.

It communicates with the MTSO over dedicated data links (wire or wireless) and with mobiles over the air waves. The MTSO also provides the interface to the *public switched telephone network* (PSTN).

Cellular networks are designed for mobile voice telephone calls. The connection between the mobile phone and the landline phone is completely different each time a call is placed. Characteristics such as amplitude and group delay for each connection vary depending upon physical length and routing of an individual call.

This variation does not affect a voice call, but it makes it difficult to maintain a data connection.

Cellular systems were designed for voice traffic, and little thought, if any, went into designing features for data users. Today's users want data traffic in the form of telemetry, interactive sessions with main-frame computers, electronic mail (e-mail) delivery and, of course, facsimile (fax) delivery. For those brave enough to try sending data on a cellular system, the remaining problems of multipath, burst and blank, cell hand-off and interference are soon evident.

A cellular system is a complex collection of hardware. Its performance is subject to a number of unique radio phenomena because of the frequencies used. These circumstances make it impossible to simulate a cellular system in the laboratory and difficult to model it on a computer. If a test of data over cellular is to be realistic, it has to be done on a working cellular

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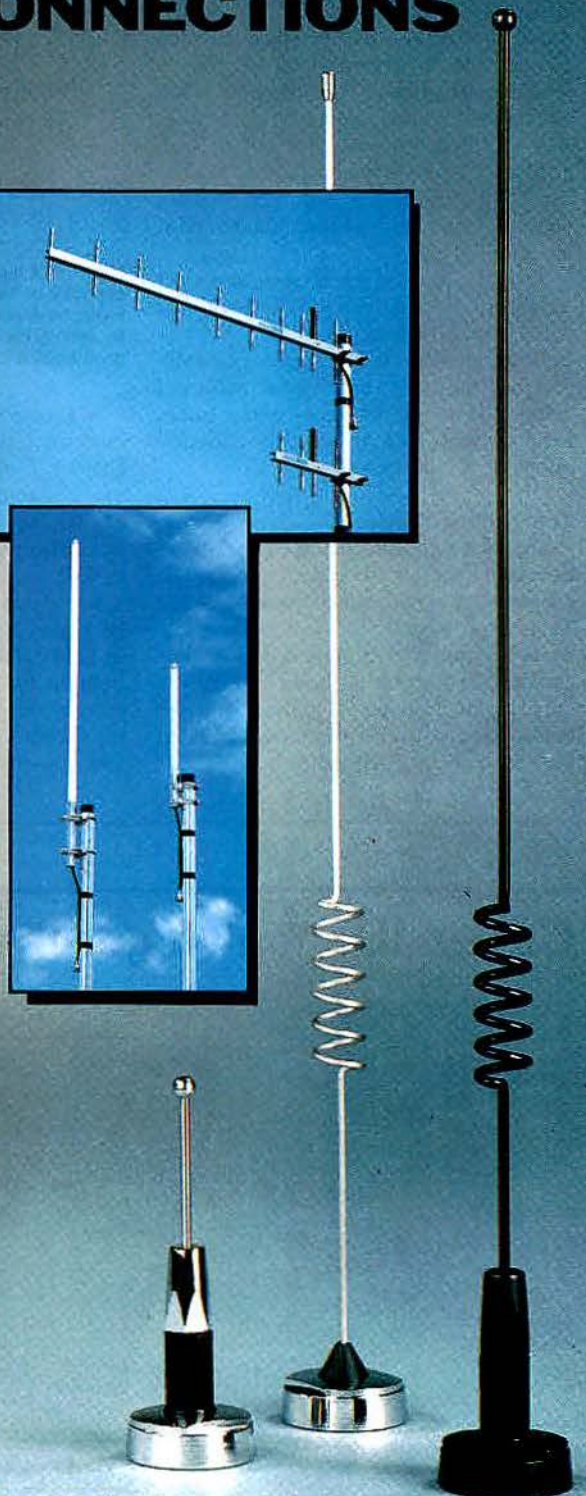

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system and not in a laboratory using simplified simulations or test models.

Modems

Prior to the introduction of AHEAD, higher speed modems that could be used on voiceband land mobile radios or a cellular system all used either DPSK or QAM modulation techniques. Many manufacturers implemented specific firmware to improve throughput. These enhancements include data compression and specific algorithms that allow higher data rates when talking to a similarly equipped modem. In addition, certain (*de facto*) standards such as MNP-10, the AT command set, MNP-5 and V.42 were also added. These, along with automatic fall-back, are found in most modems.

AHEAD, because it is so new, is not yet a standard modem, with the exception that it is backward-compatible with a V.21 or Bell 202 modem. It has been specifically designed for use on land mobile radio and cellular systems. Although it too offers MNP-10 and V.42, it does not currently offer the AT command set.

Test configurations

The test segments included the route, the cellular carrier and the equipment. The equipment also had several variations. (See Table 1 on page 12.) Of all the possible combinations, 17 are presented here. The complete test set up is shown in Figure 1 on page 10. Nothing is unique about the hardware, and every effort was made to keep it as plain as possible.

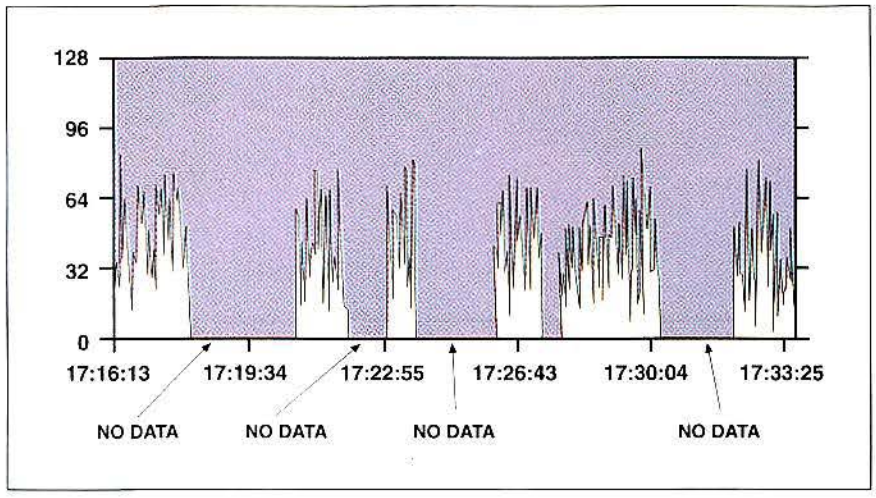

Figure 2. A typical plot of a 17-minute period during one of the 4,800bps QAM tests with a nominal capacity of 120 blocks per second. This shows the gaps that happened while the modems were trying to re-synchronize. The other unexplained phenomenon was a dropped call. This was solved by setting the S-10 parameter (AT command set) in the Microcom and Intel modems to 255. (Never drop a call for loss of carrier.) The situation that was not solved was the 'phantom drop.' (See text.)

▶ *Connections* — The connection to the modems tested is via RS-232 cable from COM 1. Connections to the PSTN line are via a standard RJ-11 connection. The MTSO and cell site are indicated for clarity, although they are part of the cellular system.

▶ *Phones and computers* — The cellular phone, modem and interface, provided by the local cellular providers, were selected from the list in Table 1. The Compaq computer recorded data, and a global positioning system (GPS) receiver, the Garmin GPS 100, provided the latitude, longitude, vehicle speed and the time that data were recorded. The equipment was powered from the 12Vdc vehicle system.

▶ *Cellular providers* — BellSouth Mobility and Cellular One supply cellular service to the Orlando area. BellSouth Mobility uses Motorola base station equipment, and Cellular One uses Ericsson GE equipment.

▶ *Routes* — The selected route required several cell hand-offs, freeway driving at 55mph to 65mph, weak-signal and strong-signal areas, areas of potential interference (such as an airport), residential sections where the typical speed limit is 30mph, open areas, areas with heavy vegetation, business districts and industrial complexes. The chosen route took, on the average, about 40 minutes to drive.

▶ *Computer hardware* — A Compaq/Contura 3/25 with two serial ports (one connected to the GPS receiver and one connected to the modem under test) collected data in the vehicle. A 486 Hewlett Packard was used at the office.

▶ *GPS equipment* — A Garmin GPS 100 unit was was used to provide coordinated universal time (UTC), latitude, longitude and speed.

▶ *Modem equipment* — Two modems were selected for the test: an Intel SatisFAXtion 400e 14,400bps and a Microcom MICROPORTE 4232BIS 14,400bps. The Microcom is advertised as cellular-compatible and was used in the vehicle. The Intel was used at the office during the DPSK and QAM tests. The AHEAD modem was supplied by Comacs Enterprises, and was used on both sides of the link when it was evaluated. All modems were powered from either wall transformers or the

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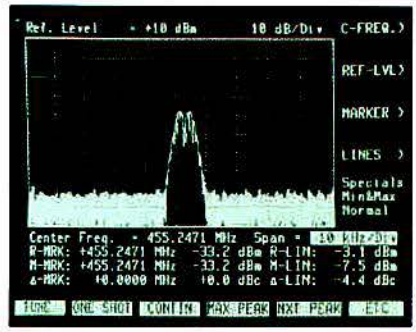

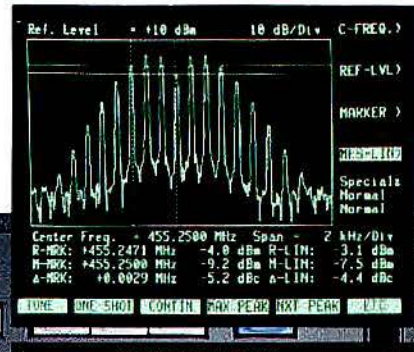

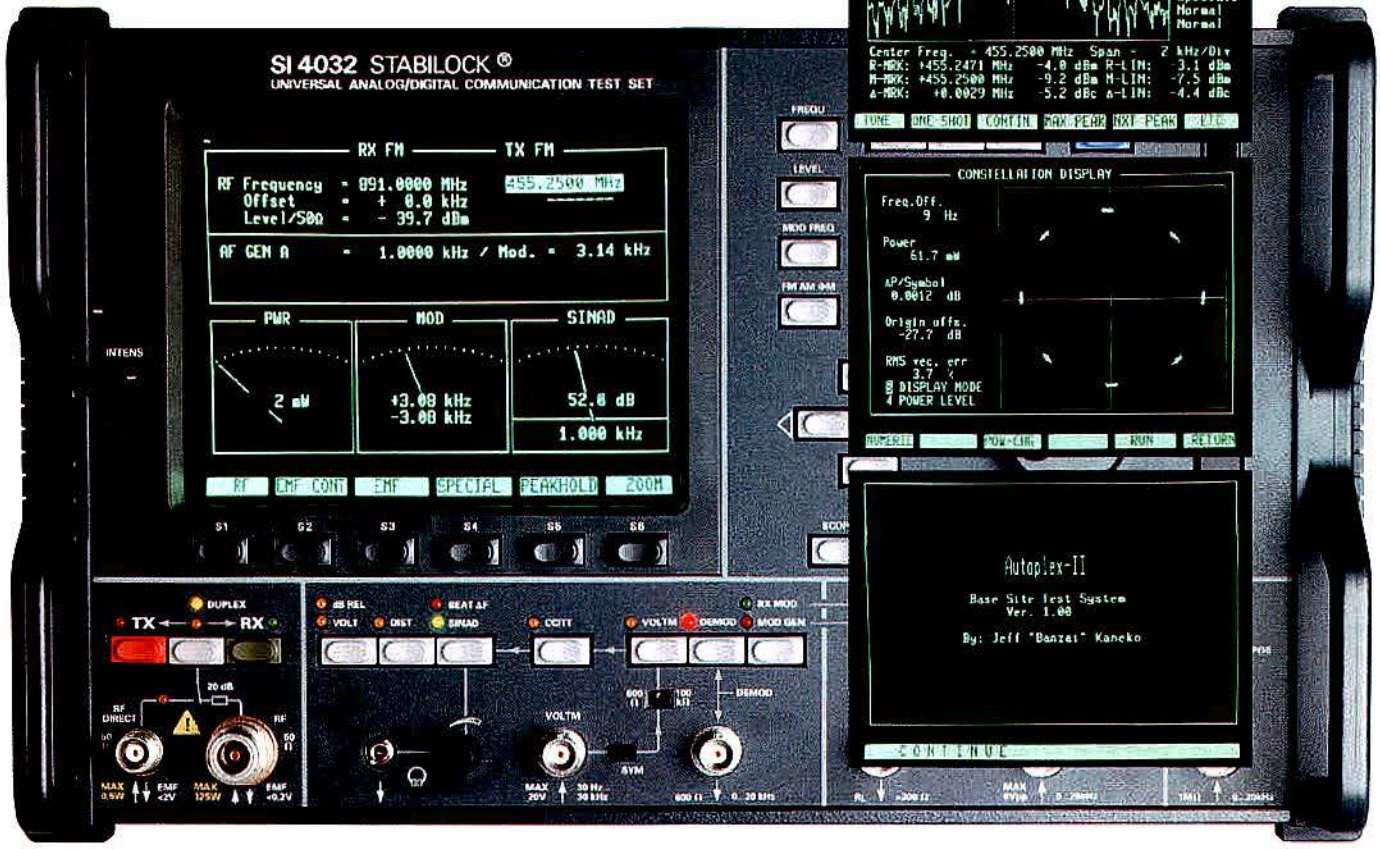

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WAVETEK

Table 2—Of all the possible equipment combinations, 17 are listed here.

TEST	DURATION	SPEED MPH	MAX	AVG.	STD. DEV.	UTILIZATION
ABOH4X	36' 32"	23.9	80+	75.3	7.4	94.1%
ACEH4Z	45' 13"	33.6	80+	76.4	4.5	95.5%
ACMH4X	32' 35"	27.0	80+	76.3	4.4	95.4%
ABOH1X	39' 37"	22.2	20+	16.5	3.5	82.4%
ACMH1X	30' 53"	28.5	20+	17.5	3.4	87.7%
ABOHAX	35' 11"	25.3	100		3.6	98.3%
ACMHAX	32' 35"	26.9	100		1.0	99.3%
DBMR4X	58' 59"	15.0	30	6.9	12.4	23.0%
DCMR4X	49' 23"	17.9	30	5.9	11.8	19.6%
DBMRAX	32' 54"	17.9	100		50.5	45.4%
DCMRAX	60' 31"	14.8	100		49.0	59.2%
QBMR4X	52' 37"	16.4	120	21.2	26.2	17.7%
QCMR4X	35' 01"	25.1	120	39.8	44.7	33.1%
QBMR1X	46' 48"	15.8	30	7.4	9.2	24.6%
QCMR1X	38' 32"	19.6	30	15.7	13.5	52.3%
QBMRAX	37' 01"	23.9	100		37.7	34.0%
QCMRAX	34' 19"	25.8	100		34.6	77.1%

12Vdc system in the vehicle.

To make a level playing field for the modems, all were reverted to the basics. Optional compression, error correction and manufacturer-specific features were turned off.

▶ *Computer software* — The Intel modem and Microcom modem were run under Procomm PCPLUS. The AHEAD modem was run under a Comacs-supplied communications program that resembles Procomm.

To evaluate the modulation waveforms effectively and to judge the performance accurately, three data situations were used in the tests. These included a four-byte block (four ASCII characters), a 16-byte block and the full printable ASCII character set.

Note: Although the AHEAD modem is transparent and could pass the complete ASCII character set, the printable character set was used because early tests showed that the Intel and Microcom modems would interpret some non-printable characters in the full set as commands.

Example: If the word "Tony" were sent from the office, the performance program in the vehicle would compare the data received to determine whether it matched the word "Tony." The correct number of "Tony"(s) received would indicate the level of performance for a four-byte block. The 16-byte blocks were sent and recorded in the same manner. The printable ASCII character set was treated differently. In this

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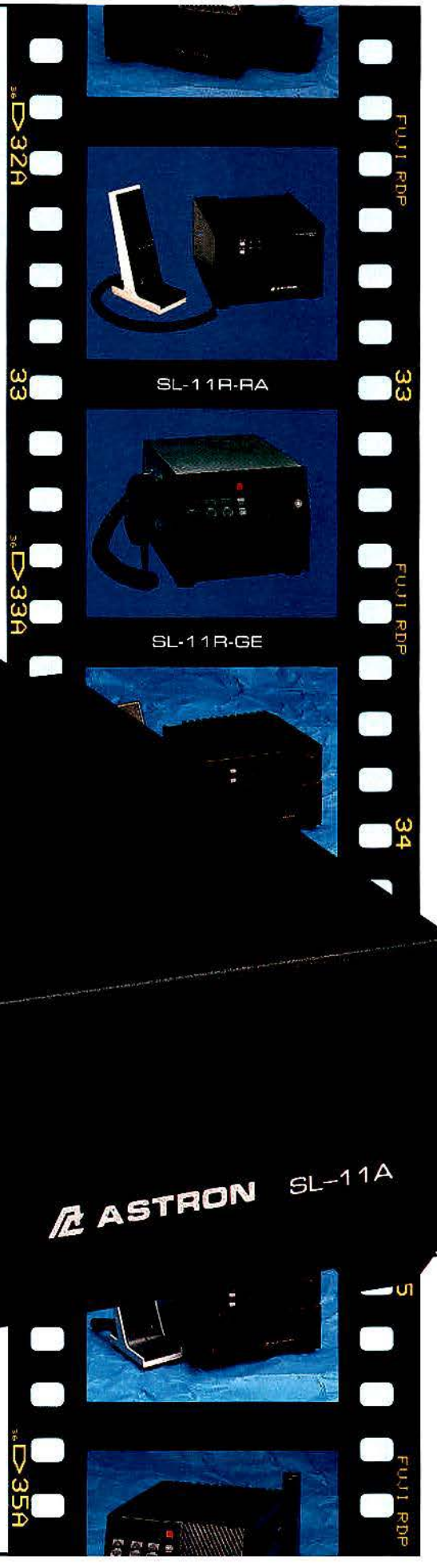

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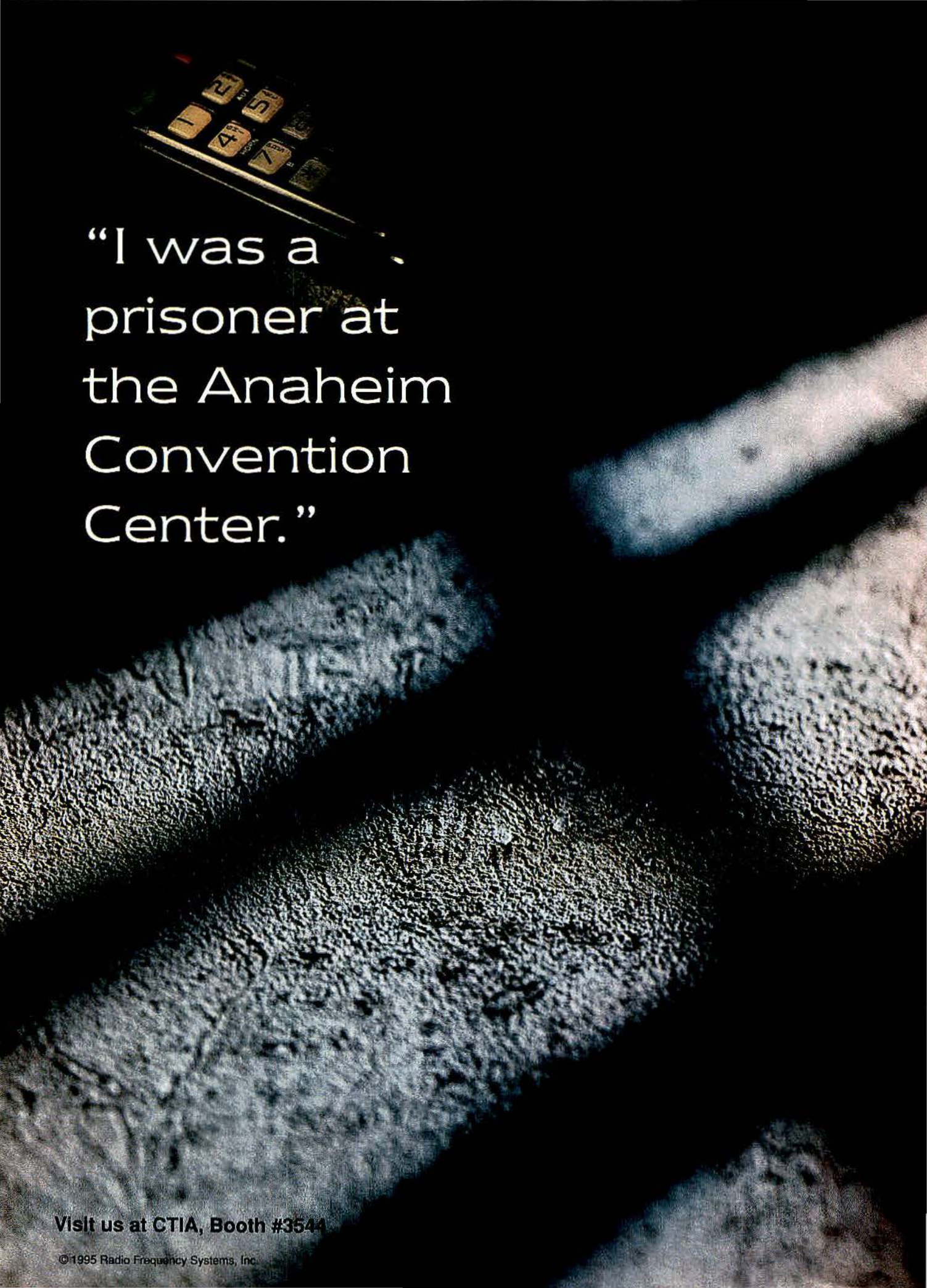
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case, the performance monitor recorded the percentage of characters that arrived in sequence correctly.

▶ *Combinations* — The equipment combinations were set up on the basis of what accessories were available. As an example, the OKI phone did not have an RJ-11 available. The Ericsson had a hands-free option but no RJ-11 option, whereas the Motorola had both. Using the equipment configurations, a simple label system was devised to create a unique name for each test.

For example, ABOH4X would identify the AHEAD modem on the BellSouth system using the OKI cellular phone receiving four-byte blocks on the hands-free option on Test Route 1. In this way, every equipment combination used in a test had a unique name. Data from a particular test could be recalled easily and analyzed.

TEST NOTATION SYSTEM

A = AHEAD modulation
D = DPSK modulation with the Microcom and Intel modems
Q = QAM modulation with the Microcom and Intel modems

B = BellSouth Mobility, Orlando
C = Cellular One, Orlando

O = Oki phone
M = Motorola Flip phone
E = Ericsson

R = RJ-11 interface
H = hands-free option

4 = four-byte blocks
1 = 16-byte blocks
A = ASCII-printable characters

X = Test route 1
Z = Test route 2

Test objectives

The test was designed to evaluate basic modulation technologies and not software such as MNP-5, MNP-10, Xmodem or Ymodem. The speeds used were DPSK (V.22) at 1,200bps, and QAM (V.32) at 4,800bps and higher. The AHEAD tests are with a setting of about 3,200bps to be in the range between 1,200bps and 4,800bps. Other AHEAD tests at higher settings (6,000+bps) are not explicitly shown, but they produced nearly identical performance.

Note: The 4,800bps speed (QAM) was selected because preliminary tests showed that a 9,600bps connection was impossible to maintain for the time necessary to make a run. Typically, if we could get a connection at all, the 9,600bps link would fail within one to three minutes.

As mentioned before, all software enhancements were disabled in each modem evaluated. This included manufacturer-specific compression features, equalization features (compensation for cellular channel anomalies) and error correction and detection features such as MNP-10.

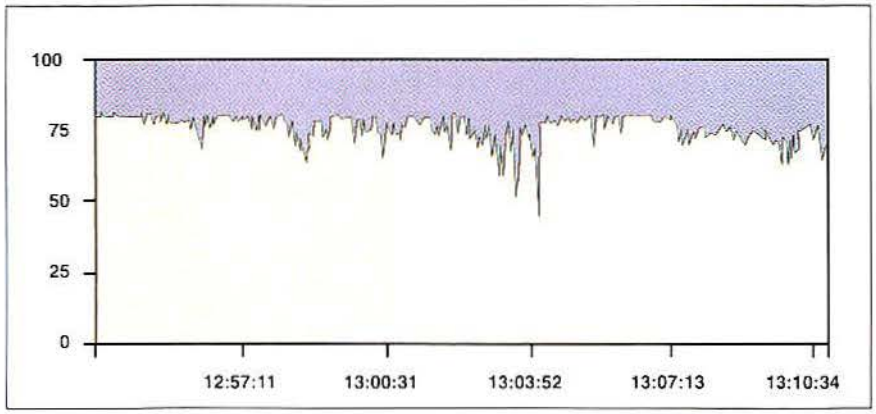

Figure 3. This plot shows the same segment of the route that Figure 2 does during an AHEAD run. The point to note is that about 80 blocks equal 100% error-free and that lesser numbers indicate errors.

Test results

The tests were conducted during a six-month period, consumed more than 300

Table 3—An overview of test results

TECHNOLOGY	4-BYTE BLOCK	16-BYTE BLOCK	ASCII	OVERALL
AHEAD at 3,200bps	95%	85%	99%	93%
DPSK at 1,200bps	21% See note	----	52%	37%
QAM at 4,800bps	25%	38%	56%	40%

Note: Sixteen-byte blocks were not sent during the 1,200bps test because the data rate was so low that one error would have represented a very high percentage and would tend to distort the statistics.

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Table 4—The summary listing of the tests.

TECHNOLOGY	BELLSOUTH	CELLULAR ONE	OVERALL
AHEAD	92%	95%	93%
DPSK	34%	39%	37%
QAM	25%	54%	40%

hours of cellular airtime between the two cellular carriers and started and ended at the same location. The receive signal level averaged about −70dBm along the route, varying between −40dBm and −116dBm. The tests provided an equal chance for each modulation technology, and every attempt was made to have a fair and impartial test that allowed the technologies to be compared without any interfering software. The results have been certified by BellSouth Mobility and Cellular One technical representatives. The 17 test runs presented here were selected as typical of the hundreds that were done and include different times of day, different days of the week, different traffic patterns and cellular system loads.

The tests provided an equal chance for each modulation technology, and every attempt was made to have a fair and impartial test that allowed the technologies to be compared without any interfering software.

Table 2 on page 16 and Table 3 on page 20 both give an overview of the tests, but what is not shown in the statistics is the percentage of time that the traditional modems spent trying to establish communications. This could be anywhere from 20 seconds to several minutes, with no assurance that they would be able to maintain a connection once it was established. While much of the re-synchronization time occurred after a cell hand-off, there were times when it "just happened," and we could not find a satisfactory explanation for it.

Figure 2 on page 14 shows a typical plot of a 17-minute period during one of the 4,800bps QAM tests with a nominal capacity of 120 blocks per second. This shows the gaps that happened while the modems were trying to re-synchronize. The other (unexplained) phenomenon was a dropped call. This was solved by setting the S-10 parameter (AT command set) in the Microcom and Intel modems to 255. (Never drop a call for loss of carrier.) The

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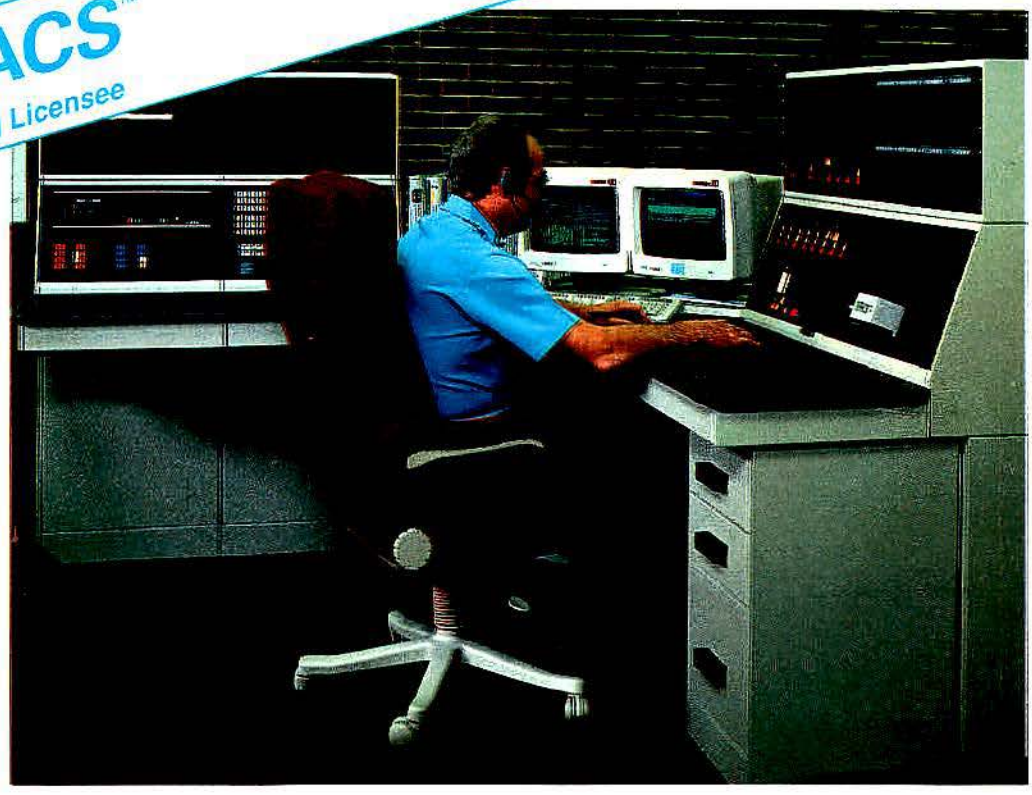

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situation that was not solved was what we called the "phantom drop." Although there was adequate signal on the cellular phone display, and loss of carrier had been disabled on the modem, the modems would just stop sending data or trying to re-synchronize. We could never predict when it would happen or under what conditions, but it caused a number of the early runs to be aborted while we looked for a solution. During the test period, the reason was never identified, but it only happened with the Microcom and Intel modem configuration. Because we could not find a reason for the problem, the monitoring software was modified to look for the condition so that the vehicle occupants could immediately reinstate the call. As a point of interest, during the testing period, the AHEAD technology never dropped a call or stopped sending data.

The plot in Figure 3 on page 20 shows the same segment of the route that Figure 2 does during an AHEAD run. The point to note is that about 80 blocks equal 100% error-free and that lesser numbers indicate errors. No modem, including AHEAD, was ever completely error free, but AHEAD was able to maintain a much higher "good data" average than any of the others tested. AHEAD gradually lost throughput in weak signal areas and never suffered from the total loss of data that the other modems experienced.

The complete listing of the tests presented is shown in Table 2 on page 16. The first series of tests shown were done with four-byte blocks. (See Figure 4 on page 26.) The results of the test series show that the AHEAD technology performed significantly better than any other modulation technology. (See Figure 5 on page 26.)

Conclusions

The AHEAD technology is well-suited to the land mobile and cellular radio environment. The claims of the inventor, Dr. Rainald Schoneberg of Comacs Enterprises, Orlando, FL, regarding throughput and performance over a radio system, have been validated with side-by-side tests.

Software, such as MNP-10, drastically improves any modem's error performance, but not actual throughput.

DPSK and QAM technologies are not well-suited for a land mobile and cellular radio environment because of the need for re-synchronizing and problems with phase distortion, as well as multipath. This is the reason that IBM, for example, announced the delay of the introduction of its personal digital assistant (PDA) because of communications problems.

Vehicle speed had little effect on data throughput for all modulation technologies. There were frequent instances where a modem under test had good data throughput at 55mph and poor throughput at 25mph. Interference from police and fire vehicles that use a trunked radio system will stop a data transmission but will have less effect on a voice conversation.

Software, such as MNP-10, drastically improves any modem's error performance, but not actual throughput. In fact, it can be said that software is used

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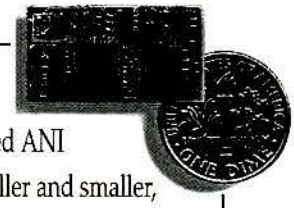

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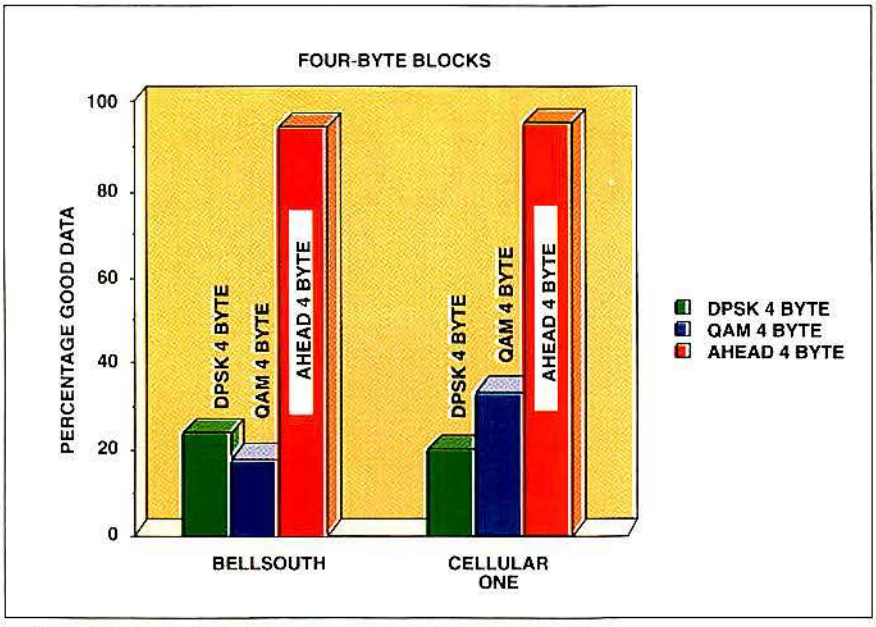


Figure 4. The first series of tests was done with four-byte blocks.

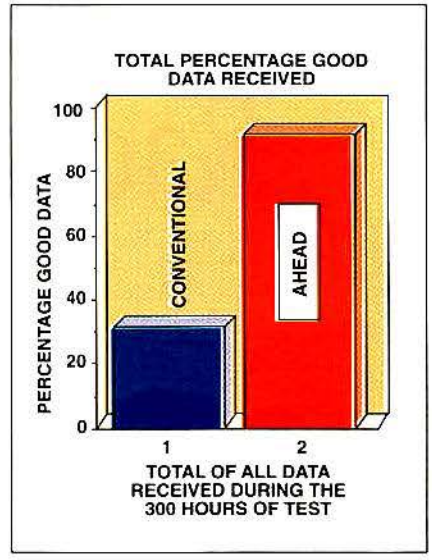


Figure 5. The results of the entire test series show that the AHEAD technology performed significantly better than any other modulation technology.

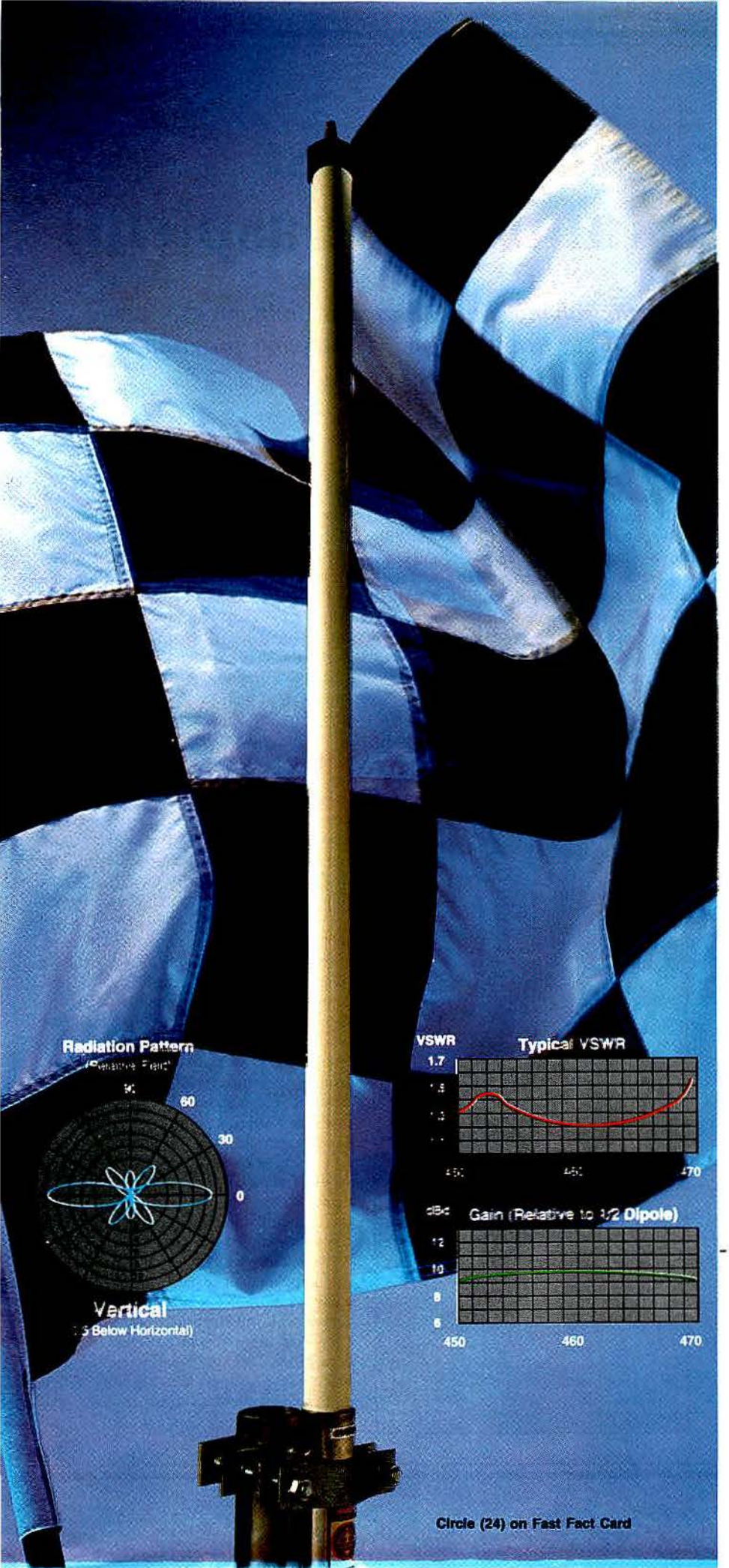
to fix the problems of older modulation technologies.

Acknowledgments

I thank Greg Griffith and Todd Byrns of BellSouth and Jim Lipsit and Tony McCray of Cellular One for their support, technical assistance and participation in verification of the tests.

I thank DK Electronics of Belleair Beach, FL, for providing the Garmin GPS 100 receiver. It performed flawlessly throughout the test.

Thanks also to Duke Miller of PNS System of Clearwater, FL, and to Dr. Schoneberg of Comacs Enterprises for his assistance and technical support.



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Servicing pagers: Headaches (and some aspirin)

Part 12—Here are some tips for solving little quirks and problems that come up from time to time with Motorola Bravo pagers. A computer program you can use to track your customers is included.

By David Ludvigson

You have just finished replacing a crystal and aligning a Motorola Bravo pager. The frequency and format problems have been solved. You go to the programmer and confidently enter the new capcode and answer the appropriate prompts with "yes." Then you page it.

"123A456B789C" shows in the display. Whaaat?

This problem is one of several poorly documented problems that occur with different versions and programming methods of and for the Bravo pagers.

Certain "hidden" programming options can remove those interfering letters, as well as the annoying chirp that sounds when the Bravo is "reminding" you to read an unread message.

When trying to program a series of pagers simultaneously, the letters "PRC" may appear on the programmer display. To fix that error, from the selection page just preceding the *READY TO PROGRAM?* prompt, depress *0* and *9* on the programmer simultaneously. This step places you in another page of programming options. (See the operator's section of the manual for a full description of what the initials mean.) It is important that the *BSVR* (battery-saver) option be enabled, so enter *Y* in response to that prompt.

The page of options that follows contains the single entry *PRC*. Entering *N* (no) here removes those interfering letters from the display. The next page again prompts for *READY TO PROGRAM?*

Customers often complain of the momentary *chirp* that precedes vibration when the pager is in its vibration-alert mode. Use the Bravo Programmer to read the pager's programming. Under OPTIONS, the SMC prompt is followed by Y, which means that the *silent mode chirp* (SMC) has been enabled. Change the *Y* to *N*, and the problem is solved.

Recall what has been written about *normal* and *inverted* code formats. It is a good idea to test the pager with your code-box just to make sure the code format is correct. If you have to switch signal polarity to cause the pager to respond, then reverse your DI selection.

Sometimes, the output signal at M1 will look dead, even when you are belting it with 10V of RF signal. Recheck the first conversion crystal frequency. It is possible that you are using a 45MHz offset crystal in a 17.9MHz receiver board (or vice-versa). The oscillator cannot work so far from its intended frequency.

Several crystal manufacturers support the Bravo. I was doing fairly well in finding crystals, and then my supply improved when I found Crystronics' "rocks." Figure 1 on page 32 lists the company's codes for VHF through 900MHz crystals. Call the company at 305-566-6949 for further information.

Tracking customers

When a merchant begins to deal in pagers, he may discover rapidly that he needs a means of keeping track of his customer base. Generally, as long as he does not exceed 200 customers, he can handle customer records with a Rolodex file. With more than 200 customers, though, it is time to look for a decent bookkeeping program.

After looking around for several months, I finally decided there was no software available that was designed for pager information filing. Several programs merely laid information down on the disk, and the user had to define whether his input was in the "Pager Number" or "Capcode" field. Then you could twiddle your thumbs while the disk found a match. The occasional "double number" problem (where two customers have the same capcode and pager number) was frustrating with some software because it would find the first match and just stay there! It was not possible to get beyond the first collision of matching data to find out what was on the other side.

Then, there was the issue of how ornate the software had to be. Were alternating color bars really necessary, or just a screen with information? How much of a hard disk drive would be occupied with actual data, and how much would be used to crunch color and location information as it printed the data to a particular spot on the screen?

Ludvigson is a technician in Houston.

Pager servicing series

Part 1: "Build a Shielded Room," January 1994. (All pagers.)
Part 2: "Build An 'IFFER,'" February 1994. (Bravo, Bravo Plus, Bravo Express.)
Part 3: "Frequencies, Coding Formats, March 1994. (Bravo.)
Part 4: "From Bench To Programmer," April 1994. (Bravo.)
Part 5: "The Receivers," May 1994. (Bravo.)
Part 6: "Elegant Simplicity," June 1994. (Bravo.)
Part 7: "Problems In Paradise," July 1994. (Bravo.)
Part 8: "406MHz–512MHz Receivers," August 1994. (Bravo.)
Part 9: "150MHz Receivers," September 1994. (Bravo.)
Part 10: "Tales Crystal Filters Tell . . .," October 1994. (Bravo, Bravo Plus, Bravo Express.)
Part 11: "Microprocessor Board," November 1994. (Bravo.)
Part 12: "Headaches (and Some Aspirin)," January 1995.

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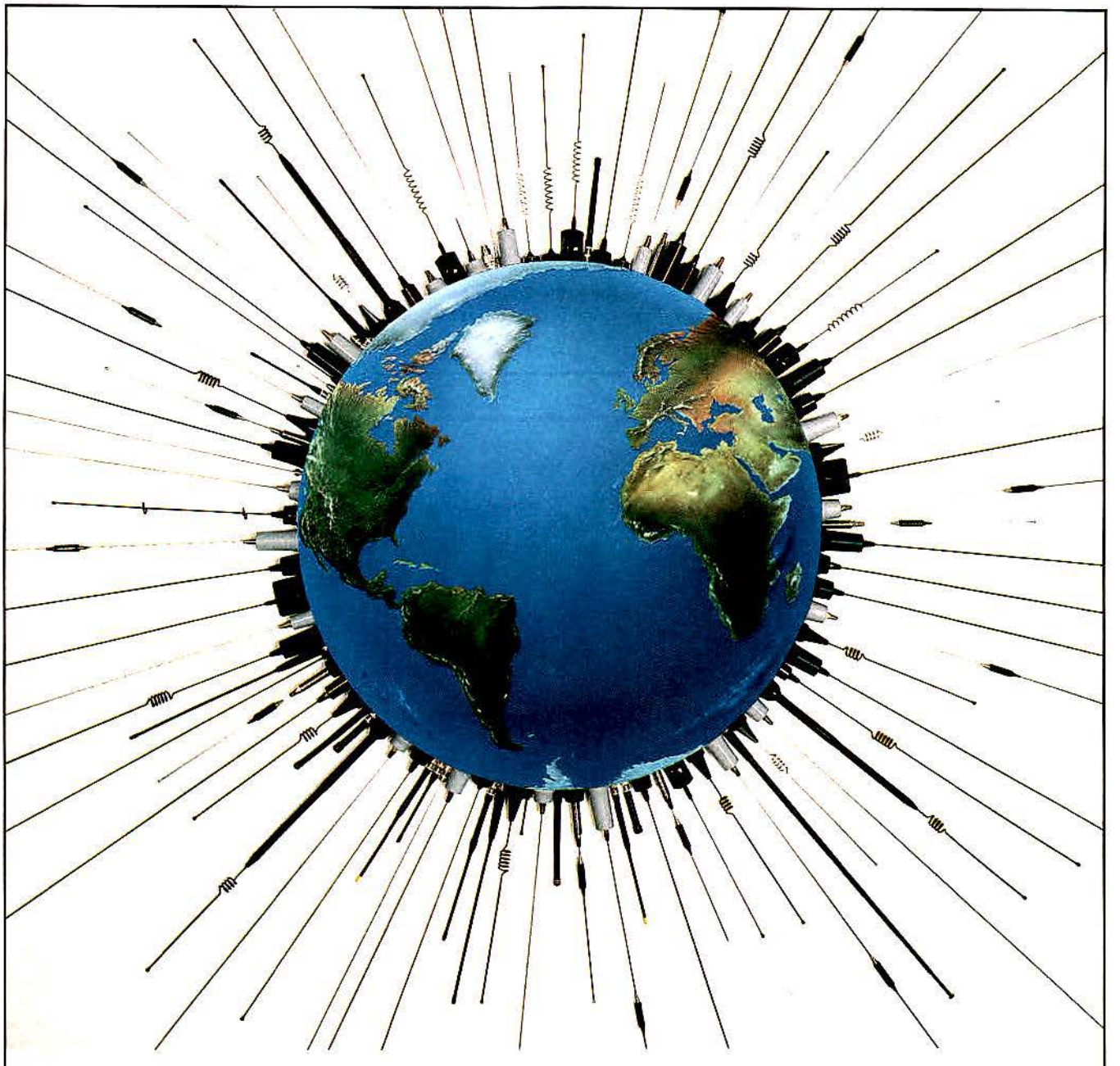

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I decided to write my own software in a (Beginner's All-purpose Symbolic Instruction Code) programming language called BASICA to see which would do the best. The results were surprising.

Heavy-duty databases use a separate data file where the information lies in wait to be displayed on the screen. Whenever you search for some data, this file is interrogated until a match is found, starting at your first file and marching through each file, one at a time. As your database increases, this search can become a huge task. One version of this sort of program uses nearly 3 million bytes of storage for the nearly 2,000 customers at JJ Sounds and Communications, South Houston, TX.

My own method is more conservative. No flashing colors, no neon, just basic business. The same 2,000 customer files *and* the program occupy *only 650K* of disk space.

The grinding of the hard drive is broken into 12 nearly identical programs that have been "chained" together, each calling the next in sequence. Information is presented in an easy-to-edit fashion, and a 12-year-old could easily update the program.

When entering data, eight fields are used in each file: *AZ$* is the pager phone number; *N* is the line number in which the data have been entered for this pager; *CC$* is the capcode for the pager; *NM$* is the customer name; *AD$* is the rate and month rental charge; *CT$* tracks special features such as voice mail or statewide coverage; *ST$* is the month-to-month payment due date; and *NT$* is used to keep track of various notes, such as our own registration number, price paid and when the last payment was received.

Often, we receive payment by check, with no more information than a name and address. Perhaps the most powerful portion of this program is found in the MID$ (midstring) function, which allows names (first, last and whole name) to be found by the program.

Pagerfiles

The Pagerfile program uses a universal entry format to allow the user merely to type in whatever information he has—without specifying the field—and the program finds the match(es).

Pagerfiles contain—within themselves—the DATA statements that pertain to your customers. These statements are edited by the screen editor, and doubly resaved so there is a backup copy of the files. Each Pagerfile starts out about 5.5K long, but it can grow rapidly, so it is a good idea to install the program on a hard disk drive.

Hard copy receipts may be generated with Pagerfiles. Automatic "next payment due" mathematics are performed within the program and printed on the receipt. Embedded commands allow the user to print files for customers with past-due payments.

Current versions of Pagerfiles are "chained" through 12 programs, each capable of 200-250 customer fields. This capacity represents 2,400 to 3,000 customers. With slight modifications to the program, Pagerfiles could be extended to several hundred programs, each capable of handling 200-250 customers.

Written in BASICA, the essential program is adapted easily to any IBM-compatible computer offering a version of BASIC, which is usually bundled with the disk operating system (DOS).

It is important to note the presence of the "echo" copy, thus doubling the memory requirements of the floppy disk or hard disk drive. Ten full copies (and "echoes") of Pagerfiles fit nicely on a

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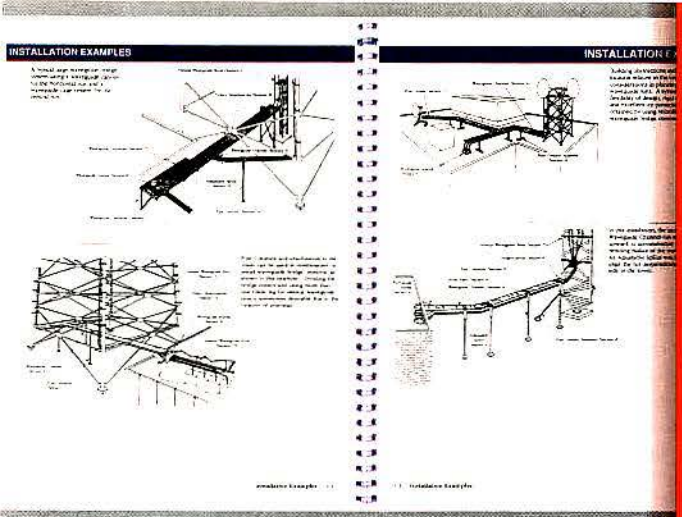
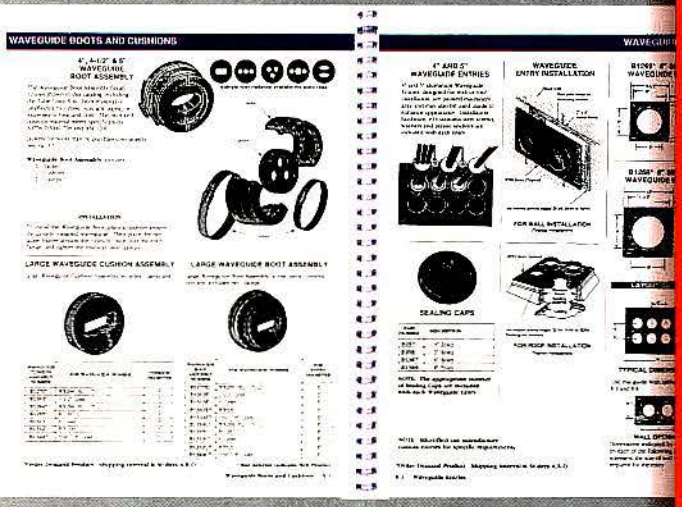
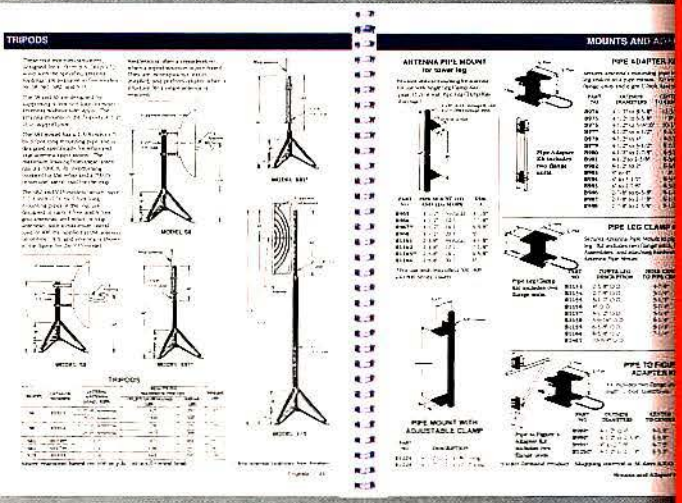
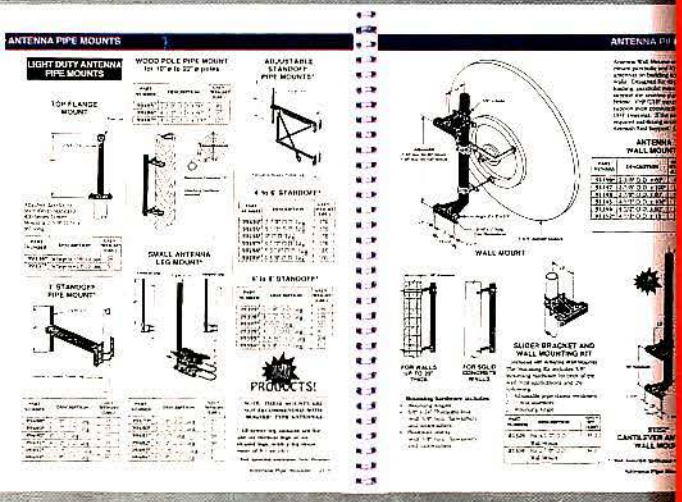
MOTOROLA		ALL
LOW	UHF	900
BR110001–35.200/L	BR310001–454.025	BR410001–929.3625
BR110002–35.220/L	BR310002–454.050	BR410002–929.3875
BR110003–35.240/L	BR310003–454.075	BR410003–929.4125
BR110010–35.500/L	BR310004–454.100	BR410004–929.4375
BR110011–35.540/L	BR310005–454.125	BR410005–929.4625
BR120011–35.540/H	BR310006–454.150	BR410006–929.5625
BR110012–35.560/L	BR310007–454.175	BR410007–929.6375
BR110013–35.580/L	BR310008–454.200	BR410008–929.6625
BR120013–35.580/H	BR310009–454.225	BR410009–929.6875
BR110014–35.600/L	BR310010–454.250	BR410010–929.7125
BR120017–43.200/H	BR310011–454.275	BR410011–929.7375
BR110019–43.240/L	BR310012–454.300	BR410012–929.7625
BR120019–43.240/H	BR310013–454.325	BR410013–929.7875
BR120022–43.340/H	BR310014–454.350	BR410014–929.8125
BR120024–43.420/H	BR310015–454.375	BR410015–929.8375
BR110028–43.560/L	BR310016–454.400	BR410016–929.8625
BR120028–43.560/H	BR310017–454.425	BR410017–929.8875
BR120029–43.580/H	BR310018–454.450	BR410018–929.9125
BR120031–43.620/H	BR310019–454.475	BR410019–929.9375
BR120033–43.680/H	BR310020–454.500	BR410020–929.9625
	BR310021–454.525	BR410021–929.9875
VHF	BR310022–454.455	BR410022–931.0125
	BR310023–454.575	BR410023–931.0375
	BR310024–454.600	BR410024–931.0625
BR210001–152.030	BR310025–454.625	BR410025–931.0875
BR210002–152.060	BR310026–454.650	BR410026–931.1125
BR210003–152.090	BR310027–462.750	BR410027–931.1375
BR210004–152.120	BR310028–462.775	BR410028–931.1625
BR210005–152.150	BR310029–462.800	BR410029–931.1875
BR210006–152.180	BR310030–462.825	BR410030–931.2125
BR210007–152.210	BR310031–462.850	BR410031–931.2375
BR210008–152.240	BR310032–462.875	BR410032–931.2625
BR210009–152.480	BR310033–462.900	BR410033–931.2875
BR210010–152.510	BR310034–462.925	BR410034–931.3125
BR210011–152.540	BR310035–465.000	BR410035–931.3375
BR210012–152.570	BR310036–464.975	BR410036–931.3625
BR210013–152.600	BR310037–457.575	BR410037–931.3875
BR210014–152.630	BR310038–452.130	BR410038–931.4125
BR210015–152.660	BR310039–455.500	BR410039–931.4375
BR210016–152.690	BR310040–452.650	BR410040–931.4625
BR210017–152.720	BR310041–457.975	BR410041–931.4875
BR210018–152.750	BR310042–454.550	BR410042–931.5125
BR210019–152.780	BR310043–464.700	BR410043–931.5375
BR210020–152.810	BR310044–456.375	BR410044–931.5625
BR210021–152.840	BR310045–464.375	BR410045–931.5875
BR210022–154.625	BR310046–452.750	BR410046–931.6125
BR210023–157.740	BR310047–453.125	BR410047–931.6375
BR210024–158.100	BR310048–456.680	BR410048–931.6625
BR210025–158.460	BR310049–463.200	BR410049–931.6875
BR210026–158.700	BR310050–463.250	BR410050–931.7125
BR210027–152.420	BR310051–449.675	BR410051–931.7375
BR210028–159.855	BR310052–464.350	BR410052–931.7625
BR210029–152.0075	BR310053–454.6125	BR410053–931.7875
BR210030–153.710	BR310054–445.600	BR410054–931.8125
BR210032–155.280	BR310055–445.675	BR410055–931.8375
BR210042–152.650	BR310056–445.825	BR410056–931.8625
BR210046–153.605	BR310057–445.950	BR410057–931.8875
BR210053–152.500	BR310058–462.625	BR410058–931.9125
BR210056–150.635	BR310059–462.200	BR410059–931.9375
BR210059–151.190	BR310060–462.350	BR410060–931.9625

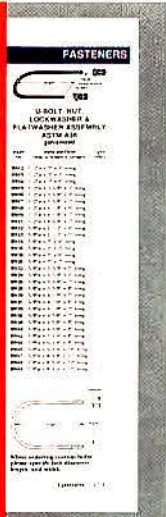
The first two characters of the model number BR = Bravo; BE = Bravo 17.9IF (900 band). The last two digits represent a specific frequency and is common for all models.

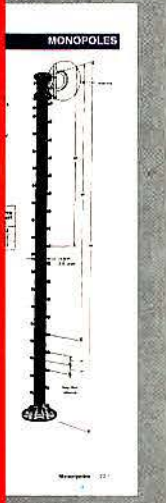


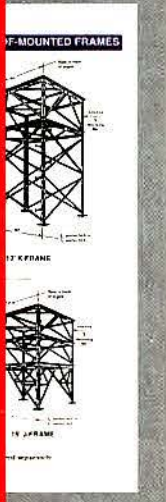












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1.44Mb floppy diskette and take care of 2,000 to 2,500 customers.

Depending on the microprocessor speed and hard drive access time, Pagerfiles sorts through 2,000 customers in about 4.5 seconds on a '486, 33MHz computer on the hard disk drive. Using a 5.25-inch diskette, the same machine takes 12 seconds. Speed is a question of machine and storage media.

Data entry consists of structuring your files around the format given (i.e., pager number, line number from the program, capcode, name, rate per month, features, monthly due date and miscellaneous and search information). Once this information is entered, begin entering data at line 500. (See program on page 36.)

Other special features may be embedded in Pagerfiles. Various portions of the NT$ may be used to indicate unassigned or inactivated pagers. A bit of imagination with Pagerfiles goes a long way toward achieving a better Rolodex index file.

Also included in Pagerfiles is a labor-saving routine that determines from the data exactly when payment is due and dials the pager number. The program downloads into any Hayes-compatible modem to leave a "get back to me" phone number that is programmed by the user. (See lines 92-116 in the program listing.)

When using BASICA, it is necessary to reset the date and time calendar-clock to print an accurate receipt. With BASICA running, type PRINT DATE$ and hit RETURN. The value of DATE$ is printed. To change it, type DATE$="mm/dd/yyyy" (with mm, dd and yyyy standing for month, date and year) and hit RETURN. To change the time, type PRINT TIME$ and hit RETURN. The value of TIME$ will appear. To change it, type TIME$="hh/mm/ss (with hh, mm and ss standing for hours, minutes and seconds in a 24-hour clock format) and hit RETURN. This step sets the internal calendar and clock, and the information will be printed on each receipt.

A documented copy of PGRFILE I is included with this article, and anyone is free to adapt, modify or use it. Copies of PGRFILES are available for a $15 check or money order. A program called PGF0 contains documentation of the program, and an INFO file provides an overview.

The following lines *must* be written carefully to allow the programs to chain properly: lines 12, 14, 20, 24, 66, 74, 78 and 100. Line 14 informs the user which Pagerfile is being used. The remaining lines handle the chaining operations.

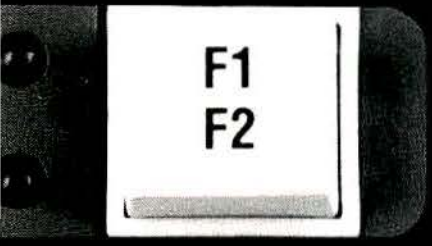
Pagerfiles are provided on 5.25-inch diskettes (formatted for 360K) and 3.5-inch diskettes (formatted for 1.44mB) for IBM-compatible computers. Indicate which version you need. Send to: David Ludvigson, 318 Avenue B, South Houston, TX 77587.

For readers interested in a Windows-style bookkeeping and billing method, I recommend a program called PAGE-KEEP, available from Electronic Information eXchange (EIX). This particular software generates reports and has numerous options such as multi-user capability, auto-page, over-call management and automatic data exchange, which provides an instant comparison between your records and those of the billing company. For further information, call 713-765-7400.

Acknowledgement

I would like to the management and staff of JJ Sounds and Communications, South Houston, TX, for their help with this project. Tel.: 713-944-1813.

Obedient Buttons



They Do What You Tell Them
(and only talk back when requested)

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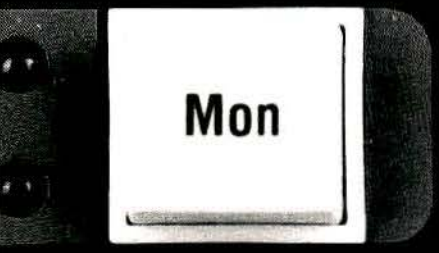
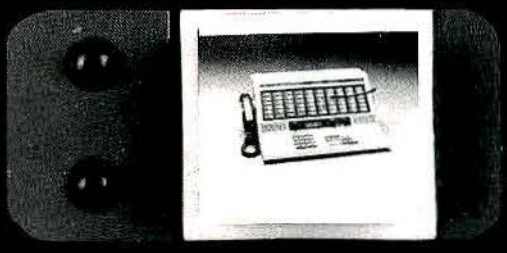
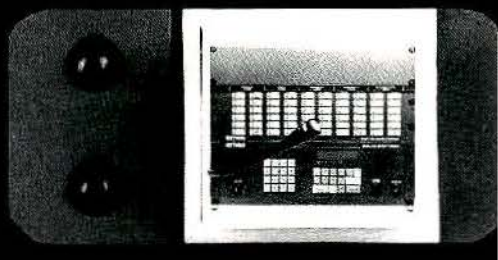
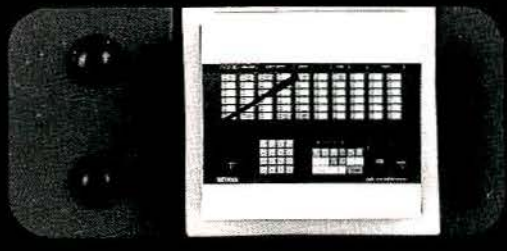
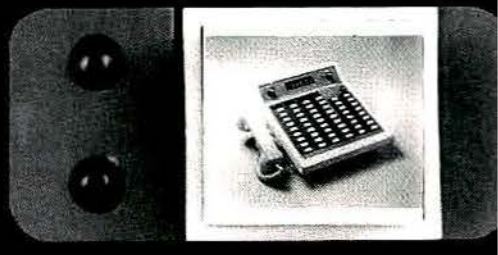
Don't let yourself get frustrated with consoles that won't do what you ask them to do. Equip your dispatch center with Zetron's communications equipment and take control today.











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Circle (32) on Fast Fact Card

The following is an abbreviated version of the program "PGF0.BAS." Some programmer remarks (REM statements) have been edited for space considerations. The complete program is available from the author.

```
10 COLOR 11,8:KEY OFF:GOTO 14
12 SAVE"PGF0":SAVE"Z":END:REM COPYRIGHT 1995, DAVID LUDVIGSON
14 CLS:PRINT:PRINT"PGRFILE1    START ALL SEARCHES FROM HERE...":PRINT:
   RESTORE:COMMON AAS,MP
16 PRINT"   THE FOLLOWING KEYS ARE RESERVED:":PRINT:PRINT" THE WORD
   (DIAL) WILL AUTODIAL ALL LATE PAGER CUSTOMERS.": PRINT:PRINT" THE
   LETTER (I) WILL PRINT INVOICE TO THE PRINTER.":PRINT:PRINT" THE
   WORD (FIND#) WILL LOCATE LATE CUSTOMERS.":PRINT:PRINT
18 INPUT"CUSTOMER NAME, PAGER PHONE NUMBER, OR CAPCODE ";AA$:
   X=LEN(AA$):COMMON AAS,MP
20 IF R=1 THEN AAS="":R=0:GOTO 14
22 READ AZS,N,CCS,NMS,ADS,CTS,STS,NTS
24 IF AAS="NEXT" THEN RUN"PGF2"
26 IF AAS="DIAL" THEN 94:REM "DIAL" HAS THE  PROGRAM DIAL ALL LATE-
   PAYING CUSTOMERS' PAGER NUMBERS AND LEAVE A "GET-BACK-TO-ME"
   PHONE NUMBER, SEE LINES 92-116, BELOW.
30 IF AAS="." THEN RUN"PGF1"
32 IF AAS="FIND"" AND MIDS(NT$,1,1)="*" THEN 138:REM LOCATE ALL PAID-UP
   CUSTOMERS
34 IF AAS="FIND#" AND MIDS(NT$,1,1)="#" THEN 138:REM LOCATE ALL LATE
   CUSTOMERS
36 IF LEFTS(AZ$,X)=AAS OR LEFT$(CCS,X)=AAS OR LEFT$(NMS,X)=AA$ THEN
   138:REM TRY TO MATCH YOUR INPUT (AAS) WITH LEADING LETTERS OF
   DATA (AZS), CAPCODE(CC$), OR NAME(NM$)
38 IF LEFTS(NT$,X)=AAS THEN 138
44 IF ASC(LEFT$(AAS,1))<65 THEN 62
46  FOR F=1 TO LEN(NM$):IF MIDS(NMS,F,X)=AAS THEN 138
48  NEXT:REM LOOK FOR MATCH BETWEEN YOUR INPUT (AAS) AND
   MATCHING CHARACTERS IN A PERSON'S NAME
50  FOR F=1 TO LEN(NTS):IF MID$(NT$,F,X)=AA$ THEN 138
52  NEXT F
62 IF AZ$<>"11111111" THEN 22
64 IF AZ$="11111111" THEN BEEP:PRINT: PRINT"          N O  F U Rh)0*0*0*H E R
   D A T A  I N  T H I S  F I L E...          ":PRINT:PRINT"
   SEARCHING NEXT PROGRAM.":REM INFORM USER OF CHAINING
   OPERATION
66  IF AZ$="11111111" THEN CHAIN"PGF2",20,ALL:REM CHAIN TO NEXT.
   INCREMENT AZ$ WITH EACH PROGRAM UNTIL PGF12, WHERE LINE 66
   READS "66 IF AZS="11111111" THEN R=1:CHAIN "PGF1",20,"
68 IF AZ$<>"11111111" THEN PRINT:PRINT"      (B)  BILLING DETERMINATION
   (C)  CONTINUE SEARCH          ":PRINT"  (L)  LIST PROGRAM LINE #
   (N)  NEXT PAGERFILE PROGRAM"
70 PRINT"      (P) PREVIOUS PAGERFILE PROGRAM      (I)  PRINT INVOICE TO
   PRINTER    ":PRINT"  (S)  SAVE CURRENT DATA TO DISK      (R OR +)
   RESET TO PAGERFILE 1"
72 Q$=INKEY$:IF Q$="" THEN 72
74 IF Q$="N" THEN CLOSE:RUN"PGF2":REM LETTER "N" WILL RUN PGF2.
   INCREMENT THIS VALUE WITH EACH PROGRAM UNTIL PGF12, WHERE LINE
   74 READS "IF Q$="N" THEN CLOSE:RUN "PGF1"."
76 IF Q$="R" OR Q$="+" THEN CLOSE:RUN"PGF1"
78 IF Q$="P" THEN CLOSE:RUN"PGF1":REM INCREMENT THIS VALUE WITH
   EACH PROGRAM UNTIL PGF12.  THERE, LINE 78 WILL READ "78 IF Q$="P"
   THEN CLOSE:RUN"PGF11"."
80 IF Q$="L" THEN PRINT"  PROGRAM ENDED... TYPE WORD (LIST) FOLLOWED
   BY LINE NUMBER...":END:REM THE LETTER "L" DROPS YOU INTO
   "IMMEDIATE" MODE (NO LONGER RUNNING THE PROGRAM)TO MODIFY
   FILES WITH THE SCREEN EDITOR
82 IF Q$="S" THEN 12:REM ALL DATA IS SAVED TO PGF# AND BACKUP
   PROGRAM DROPS INTO IMMEDIATE MODE AFTER SAVING.
84 IF Q$="I" THEN FLAG=1:CLS:FOR X=1 TO 7:PRINT:NEXT:GOTO 138
86 IF Q$="C" THEN 62
88 IF Q$="B" THEN 128:REM THE LETTER "B" PROMPTS FOR THE NUMBER OF
   MONTHS TO BE PAID (1 THROUGH 12).  SEE LINES 128-194, BELOW.
90 GOTO 72
92 REM INSERT DIALER HERE. THE FOLLOWING ROUTINE WILL WORK WITH
   HAYES-COMPATIBLE MODEMS.
94 RESTORE:AS="AT M2 L3 S11=50 DT":CS="....1234567#"+",ATH0.+++,":REM
   INSERT YOUR "GET BACK NUMBER" AT "1234567" AND LEAVE THE "#"
   WHERE IT IS!
96 OPEN "COM2:300,N,8,1,CS1000,DS1000" AS #1:REM OPEN COM2 MAY BE
   REPLACED WITH THE COM PORT YOU USE FOR YOUR HAYES-COMPAT-
   IBLE MODEM.
98 TDM=VAL(MIDS(DATE$,1,2)):TDD=VAL(MID$(DATE$,4,2)): TDY=
   VAL(MIDS(DATE$,9,2)):REM THIS LINE LOOKS FOR THE COMPUTER'S IDEA
   OF DATE AND TIME.  REMEMBER TO ANSWER THE PROMPTS CORRECTLY
   WHEN STARTING PAGERFILES!
100 READ AZ$,N,CC$,NM$,ADS,CT$,STS,NTS:IF AZS="11111111" THEN CHAIN
   "PGF2",98,ALL:REM DIALER IS SEQUENTIALLY READING LATE PAY
   CUSTOMER DATA.  INCREMENT PGFX TO CHAIN THROUGH ALL
   PAGERFILES
102 MP=1:BDM=VAL(MIDS(STS,1,2)):BDD=VAL(MIDS(ST$,4,2)):
   BDY=VAL(MIDS(STS,7,2)):NDM=BDM+MP:NDY=BDY: NDD=BDD:REM
   PRELOAD MP WITH 1.  STS IS 8 CHARACTERS LONG (01/03/94, FOR
   INSTANCE).  THIS DETERMINES NEXT DUE DATE.
104 IF NDM=>12 THEN FX=FX+1:NDY=BDY+FX:NDM=NDM-12:GOTO 104:REM
   CALENDAR CHECK
```

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Circle (35) on Fast Fact Card

```
106 IF NDM=2 AND BDM=>28 THEN NDM=NDM+1:GOTO 110:REM CALENDAR
    CHECK
108 IF NDM=4 OR NDM=6 OR NDM=9 OR NDM=11 AND NDD=<31 THEN
    NDD=BDD:GOTO 112:REM CALENDAR CHECK
110 NDD=BDD:IF NDM=0 THEN NDM=12:REM CALENDAR CHECK
112 IF TDM=>NDM AND TDD=>NDD AND TDY=>NDY THEN 118:REM CALENDAR
    CHECK
114 IF TDM=>NDM THEN DIFF=TDM-NDM:IF DIFF=>1 THEN 118:REM CALENDAR
    CHECK
116 GOTO 100:REM LOOP BACK FOR NEXT DATA
118 PRINT#1,AS+AZS+CS:CLS:FOR X=1 TO 4:PRINT:NEXT:PRINT"
    DIALING...":AZS:BDM=0:BDD=0:BDY=0:NDY=0:NDD=0:DIFF=0:FOR T=1 TO 40
    * 10000:NEXT:GOTO 100:REM MODEM IS ACTIVATED AND DOWNLOADED
    WITH DATA FROM LINE 94 AND PAGER #.
120 REM THE ROUTINE FROM LINE 92 TO 118 IS DATE-SENSITIVE.  IT DIALS
    THE NUMBER ON, OR AFTER, THE DUE DATE.
128 CLS:FOR X=1 TO 4:PRINT:NEXT:INPUT"    PAYMENT IS FOR HOW MANY
    MONTHS (0 - 12) ":MP
130 IF MP<0 OR MP>12 THEN 128
138 CLS:PRINT:PRINT:PRINT:PRINT:PRINT:PRINT SPC(5);"PAGER NUMBER =
    ";AZ$:ST=0:SF=0:TX=0:SH=0:SG$="":IF FLAG=1 THEN LPRINT:LPRINT
    SPC(26);" ***    INVOICE    ****:LPRINT SPC(51);DATE$;"    ";TIME$:LPRINT
140 PRINT SPC(5);"INFO ON LINE # ";N:IF FLAG=1 THEN LPRINT " YOUR NAME
    HERE    ";SPC(38);NM$
142 PRINT SPC(5);"CAPCODE      = ";CC$:IF FLAG=1 THEN LPRINT" YOUR
    ADDRESS HERE   ";SPC(37);AZ$
144 PRINT SPC(5);"CUSTOMER NAME:";NM$:IF FLAG=1 THEN LPRINT" CITY,
    STATE, ZIP....";SPC(37);CC$
146 IF LEN(CT$)=>5 THEN SF=5:REM THIS IS OPTIONAL.  IT DETERMINES
    PRICING BASED ON VOICEMAIL OR STATEWIDE SERVICES.  SF= THE
    DOLLAR VALUE FOR SUCH SERVICES.
148 IF LEN(CT$)<5 THEN SF=0:CT$="NONE":REM BY CHECKING THE LENGTH
    OF CT$, WE KNOW THE WORD "VOICEMAIL" OR "STATEWIDE" AUTOMATI-
    CALLY ADDS $5.00 TO PRICING.
150 IF FLAG=1 AND MP>=3 AND MP<=5 THEN AD$="8.99":REM OPTIONAL PRICE
    BREAKS.  BETWEEN 3 TO 5 MONTHS PREPAID RESULTS IN A MONTHLY
    RATE OF $8.99.
152 IF FLAG=1 AND MP>=6 THEN AD$="6.99":REM PAYMENTS OF 6 MONTHS
    OR MORE DROP THE PRICE TO $6.99 PER MONTH.
154 ST=(VAL(AD$)+SF)*MP:TX=(ST*1.0725):DP$=".":REM ADD DISCOUNT RATES
    (AD$) + FEATURES RATES (SF) TIMES # OF MONTHS PAID.  DETERMINES
    OVER-ALL SALES TAX AND TOTAL.  SET VARIABLE TX TO
    "TX=(ST*1.XXXX)" FOR YOUR TAX RATE!
156 SG$=STR$(TX):U=INSTR(SG$,DP$):V=U+3:SH$=LEFT$(SG$,V): IF
    VAL(RIGHT$(SH$,1))<5 THEN 160:REM ROUNDING
158 SG$=STR$(TX):U=INSTR(SG$,DP$):V=U+3:SH$=LEFT$(SG$,V) :IF
    VAL(RIGHT$(SH$,1))=>5 THEN TX=TX+.01:SG$=STR$(TX):
    V=U+2:SH$=LEFT$(SG$,V):REM ROUNDING
160 SG$=STR$(TX):SH=VAL(SH$):REM "SH" IS THE GRAND TOTAL, INCLUDING
    TAX.
162 BDM=VAL(MID$(ST$,1,2)):BDD=VAL(MID$(ST$,4,2)): BDY=
    VAL(MID$(ST$,7,2)):N DM=BDM+MP:NDY=BDY:NDD=BDD: REM DETERMINE
    NEXT DUE DATE WHICH WILL BE ENTERED IN ST$
164 IF NDM=>12 THEN FX=FX+1:NDY=BDY+FX:NDM=NDM-12:GOTO 164:REM
    CALENDAR CHECK
166 IF NDM=2 AND BDM=>28 THEN NDM=NDM+1:GOTO 172:REM CALENDAR
    CHECK
168 IF NDM=4 OR NDM=6 OR NDM=9 OR NDM=11 AND NDD=<31 THEN
    NDD=BDD:GOTO 172:REM CALENDAR CHECK
170 NDD=BDD:IF NDM=0 THEN NDM=12:REM CALENDAR CHECK
174 PRINT SPC(5);"RATE PER MONTH = ";AD$:IF FLAG=1 THEN LPRINT" (123)
    456-7890";SPC(43);CT$
176 IF FLAG=1 THEN LPRINT"_____
    _____";
178 IF FLAG=1 THEN LPRINT:LPRINT SPC(28);"RATE PER MONTH = ";:LPRINT
    USING "$###.##";VAL(AD$)+SF:REM PRINTER INFO
180 PRINT SPC(5);"OTHER FEATURES:";CT$:IF FLAG=1 THEN LPRINT"EXTRA
    FEATURES = ";CT$;:HF=66-(LEN(CT$)+17):LPRINT SPC((HF)-8);"SUBTOTAL =
    ";:LPRINT USING "$###.##";ST:REM DISPLAY AND/OR PRINTER DATA
182 PRINT SPC(5);"LAST PAID      = ";ST$:IF FLAG=1 THEN LPRINT"LAST PAID ...
    ";ST$;:HF=66-(LEN(ST$))  :LPRINT SPC((HF)-24);"7.25 % TAX = ";:LPRINT
    USING "$###.##";SH-ST
184 PRINT"FURTHER INFO: ";NT$:IF FLAG=1 THEN LPRINT"MONTHS PAID =
    ";MP:SPC(44);"TOTAL = ";:LPRINT USING"$###.##";SH
186 PRINT:PRINT SPC(20);"NEXT PAYMENT WILL BE DUE ";NDM;"/";NDD;"/";NDY
188 IF FLAG=1 THEN LPRINT:LPRINT SPC(23);"NEXT PAYMENT IS DUE...";NDM;"/
    ";NDD;"/";NDY
190 IF FLAG=1 THEN LPRINT:LPRINT SPC(12);"SIGN
    _____";
192 IF FLAG=1 THEN LPRINT:LPRINT SPC(35);"THANK YOU":FLAG=0
194 GOTO 68:REM LOOK FOR MORE KEYBOARD ENTRIES.
196 REM SAMPLE DATA = 9120123(PAGER #),192 (PROGRAM LINE #),
    9876543(CAPCODE),BILL SMITH(NAME),10.00 (AMOUNT DUE),VOICE MAIL
    (SPCL),11/24/94 (LAST PAYMENT DATE),PURCHASED FOR $119.24 11/24/94
198 REM LINE WOULD LOOK LIKE "DATA 9120123,194,9876543,BILL SMITH,10.00,
    VOICE MAIL,11/24/94," PAID $119.24 11/24/94 AIRTIME PAID (10) JAN.03.94
    "
200 REM DATA 1234567,196,0987654,BILL SMITH,10.00,?,01/01/93,# PURCHASED
    FOR 119.50
202 REM DATA STARTS AT LINE 500.  REMOVE SAMPLE DATA
500 DATA 9043249,500,1234987,JOHN DOE,10.00,?,03/07/94,"
501 DATA 7174403,501,4321789,JAMES DOE,6.95,?,12/30/93,#
9999 DATA 11111111,0,0,0,0,0,0,0:REM LAST LINE PGF1
```

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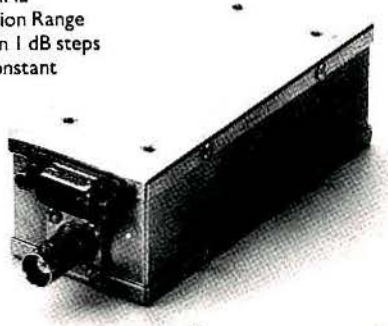

Model 50P-609
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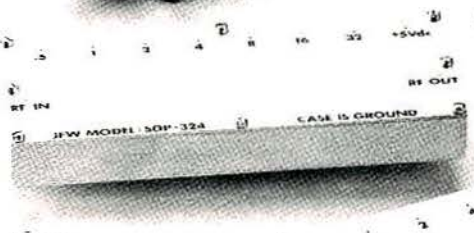
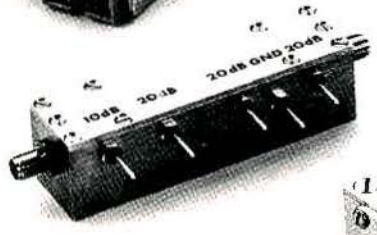
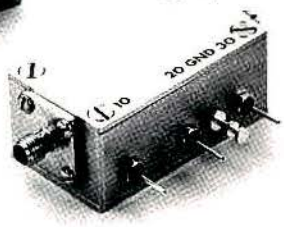
20-1000 MHz
Attenuation Range
0-63.5 dB in .5 dB steps

Model 50P-324
Frequency Range
10-300 MHz
Attenuation Range
0-63.5 dB in .5 dB steps
Phase Constant

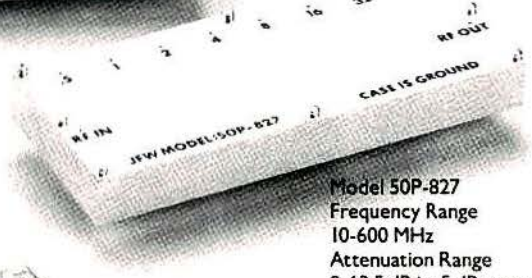




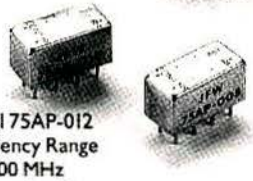
Model 50P-766
Frequency Range
DC-5 GHz
Attenuation Range
0-70 dB in 10 dB steps



Model 50P-856
Frequency Range
DC-1000 MHz
Attenuation Range
0-60 dB in 10 dB steps



Model 50P-827
Frequency Range
10-600 MHz
Attenuation Range
0-63.5 dB in .5 dB steps
Phase Constant



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Frequency Range
20-1000 MHz
Attenuation Range
0 to 25 dB minimum

Model 75AP-008
Frequency Range
20-600 MHz
Attenuation Range
0 to 25 dB minimum

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Circle (38) on Fast Fact Card

Using voting receivers and towertop amplifiers

Whether to use voting receivers or towertop amplifiers to improve radio coverage may depend on terrain, site noise and the presence of strong unwanted signals at the repeater site, among other factors.

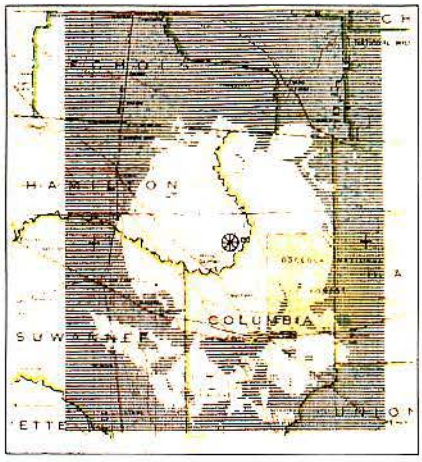

Figure 1. This coverage area is for base station talkout to a portable for a central Florida 860MHz system with a 100W transmitter, 10dB gain antenna, 95% reliability for −110dBm reception at the coverage area edge.

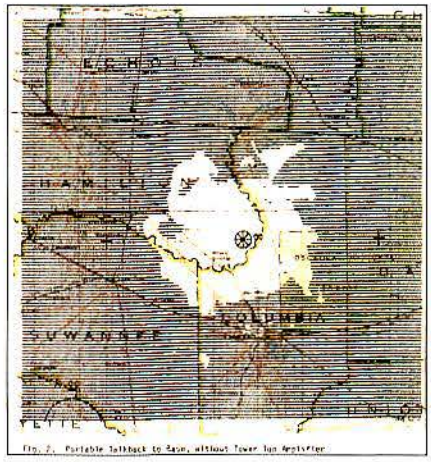

Figure 2. This coverage area is for portable talkback to base, without a towertop amplifier, for the system in Figure 1, using a 3W portable, a 10dB gain base receive antenna and −110dBm reception from the coverage area edge.

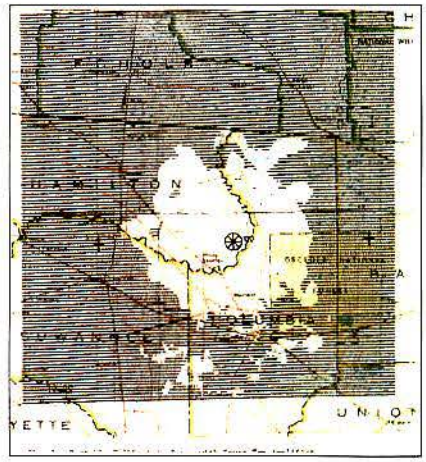

Figure 3. The portable talkback-to-base coverage area is improved slightly compared to Figure 2 by a towertop amplifier that improves system sensitivity about 3dB.

By Gordon F. Sargent, P.E., D.E.

Many system choices affect radio coverage, such as transmit power, antenna height and frequency.

As much as possible, the system designer chooses these characteristics according to coverage requirements. Other choices improve radio coverage within a perimeter or extend coverage to greater distances.

Two such choices that make a large difference are towertop amplifiers and voting receiver sites (also known as auxiliary receiver sites). Even though they both extend radio coverage, they serve different functions, and neither is a substitute for the other.

Towertop amplifiers improve weak signal detection by improving or extending base station receiving system sensitivity. Improved sensitivity slightly enlarges the coverage area and improves reception from marginal locations inside the coverage area. (See Figures 1, 2 and 3 above.)

A voting receiver site provides site diversity that helps to protect against fading and signal-blocking within the coverage area. It allows the system to receive signals from low-powered portable radios that would be too weak to be received at the repeater site.

Voting receiver sites and voting equipment provide redundant signal paths that also improve overall system reliability and sustain communications—despite some equipment failure. This redundancy is especially advantageous if the system has only one receive site and no backup site. A voting receiver site can function as a backup site as well as provide enhanced coverage under normal operating conditions.

Improving sensitivity

The main purpose of towertop amplifiers is to improve receiving system sensitivity. This improvement generally allows the detection of weaker signals than is possible without a towertop amplifier. A trade-off is that the level of noise and the level of adjacent carriers increases, too, which can increase unwanted receiver intermodulation products.

A towertop amplifier's gain and low noise figure can improve sensitivity, but the amplifier cannot compensate for the 10dB–12dB power difference between a base station transmitter and a portable transmitter. A towertop amplifier amplifies the received noise along with the signal; therefore, weak signals from the edge of the coverage area that have a low carrier-to-noise ratio (C/N) are not

Sargent is manager of automated system design, Ericsson GE Mobile Communications, Lynchburg, VA. He is a registered professional engineer, and he has a doctor of engineering degree from the University of Kansas.

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Circle (39) on Fast Fact Card

How a towertop amplifier improves system noise figure

The relationship between receive system loss and noise figure is shown by the following function:

$$F_{composite} = F_1 + \frac{F_2 - 1}{G_1} + \frac{F_3 - 1}{G_1 \times G_2} \quad \frac{\cdots F_i - 1}{G_1 \times G_2 \cdots G_r}$$

$F_{composite}$ = composite noise figure at receive system input

F_1 = noise figure of first item in system

F_2 = noise figure of second item in system

F_i = noise figure of last item in system, the receiver

G_1 = gain or loss of first item in system

G_2 = gain or loss of second item in system

G_r = gain or loss of next-to-last item in system, just ahead of the receive, such as a multicoupler

Notes: The noise figure of a lossy device is equal to its loss.

Noise figures, gains and losses are in ratios.

improved by amplifier gain.

(If towertop amplifier gain *could* compensate for the 10dB–12dB transmitter power difference, then all systems would be designed with a 30dB towertop amplifier, and portable talkback coverage would exceed talkout coverage.)

Signal quality and C/N

Received signal quality limits the maximum FM radio range or coverage area. Quality is a function of the C/N ratio at the receive antenna port. The minimum C/N ratio that produces an acceptable demodulated audio signal determines the range or coverage area.

As the received signal travels from the receive antenna port to the receiver, the C/N ratio is degraded (decreased) by receive system losses. The relative decrease in C/N ratio is a direct function of the receiving system noise figure, F, at the antenna port looking in the direction of the receiver. Any receiving system loss causes the noise figure, F, to increase, which causes the received C/N ratio to decrease; therefore, a system design goal is to minimize receive system loss by minimizing the receiving system noise figure, F.

The relationship between receive system loss and noise figure is shown by the function in the box to the left. This function illustrates the use of a towertop amplifier in improving system noise figure.

The cumulative effect of the gain, loss and noise figure of the first and second items in the receive system chain tends to dominate the composite noise figure. If the first item is an amplifier, then the system's

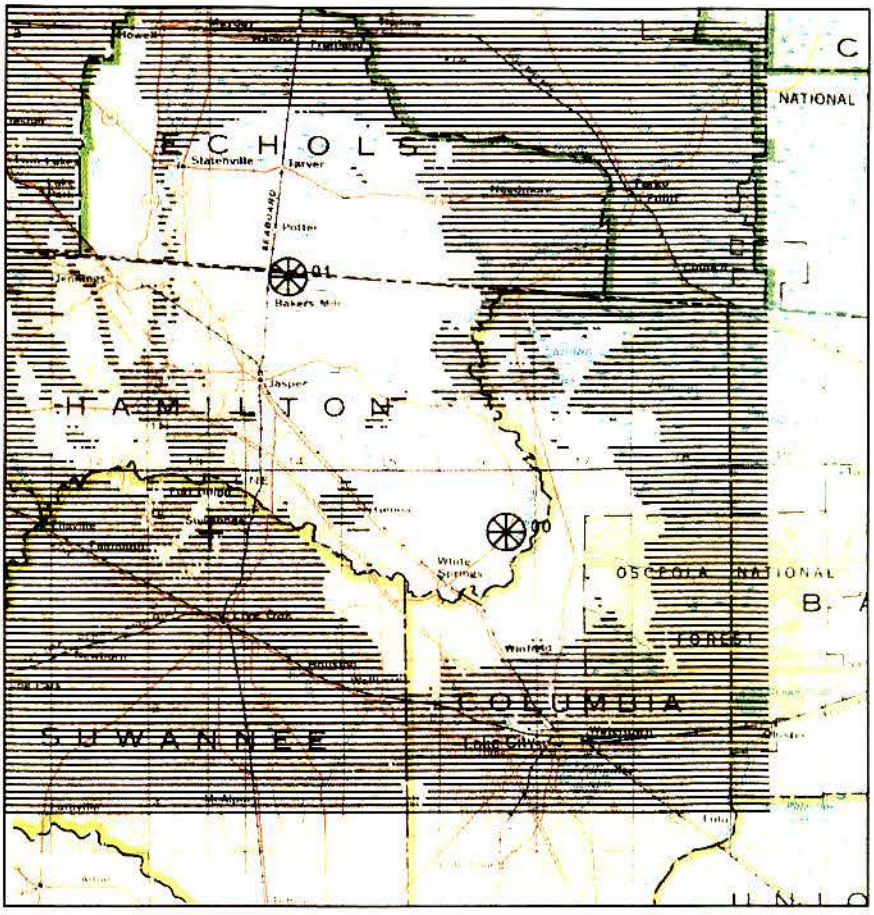


Figure 4. This coverage area shows the result of adding a satellite receiver to the system shown in Figure 2, without using towertop amplifiers. Coverage is substantially improved to the northwest of the original site.

composite noise figure is approximately equal to the amplifier noise figure. If the first item is cable loss, then the composite noise figure is approximately equal to the total cable loss plus the noise figure of the first active device (after the loss), such as a multicoupler or receiver.

The main consideration in using a towertop amplifier is to minimize system noise figure degradation caused by cable loss and other losses in the receive system, such as filters, isolators and connectors.

Where amplifiers work best

Improving the received C/N ratio can have a noticeable effect on radio coverage; nevertheless, the effect on radio coverage depends to a great extent on the kind of terrain, terrain elevation variations and the distance to the coverage edge. In areas where path loss changes rapidly with small changes in location, such as mountainous areas, small changes in receive system loss or C/N ratio do not have a great effect.

In areas where the path loss changes slowly over distance, radio coverage can be extended noticeably with towertop amplifiers. Examples include the relatively flat terrain in the southeastern U.S. coastal area.

Use caution when strong signals in the area could cause high levels of intermodulation products in the receiver.

Before deciding to use towertop amplifiers, consider whether the objective is to improve system sensitivity—meaning the system's ability to detect weak signals. The improvement offered by towertop amplifiers generally is noticeable only in weak signal areas. It loses its practical advantage in strong signal areas or where the radio path is completely blocked by mountains, hills or man-made obstructions. For these situations, multiple sites are required.

Site diversity

Voting receiver sites with auxiliary receivers provide *site diversity* that is analogous to *space diversity*. RF signals received at several sites are compared on the basis of their signal-to-noise (S/N) ratio in a voting or selection subsystem at a central location. The receiver with the best *S/N* ratio is selected, and the demodulated audio from that receiver is used for communication.

Voting receiver sites are used in several system configurations: *simulcast*,

multisite and *single-transmitter* systems. Voting receiver subsystems are used for different reasons, and with different results, in each configuration.

Simulcast systems use voting receivers at all simulcast transmit sites so the talkback channel from a portable or mobile can be received from any location in the simulcast area. The receivers are voted because the receive frequencies at each simulcast site are duplicated at all sites in the simulcast area.

In a multisite system, receive frequencies are duplicated at several sites so a talkback channel can be established over a wide area. In these two examples, voting receivers are an integral part of the system design. (See Figure 4 on page 43.)

Any system, whether simulcast, multisite or single-site, can benefit from diversity reception and receiver voting.

In a single-transmitter site configuration, voting receivers are used at satellite sites (auxiliary receiver sites) to extend coverage into selected areas. Because of the power difference between a talkout and talkback path, each path's predicted coverage area is different. A satellite receiver site can fill reception from critical areas not covered reliably for talkback from a low-power portable radio.

Coverage differences

Sometimes there may be a difference between the transmit and receive antennas' footprints because their locations on the tower may be different. The transmit antenna may be ideally located with an unobstructed view atop a tall structure. The receive antennas may be on the side of the structure where their view is partially blocked. If so, the talkback coverage area suffers and, therefore, can benefit from the use of a satellite receiver site.

Any system, whether simulcast, multisite or single-site, can benefit from diversity reception and receiver voting. With diversity reception and receiver voting, the percentage of time that a signal is blocked or faded can be reduced significantly. Signals received from a mobile or portable at several base stations are compared at every instant, and the best signal is always selected. Diversity reception is a powerful tool that has been used in mobile radio systems for many years.

(continued from page 8)

the 12dB SINAD sensitivity test. Then, increase the signal generator level 6dB above the level required for 12dB SINAD sensitivity, or twice the microvolt level. The SINAD reading should improve greatly with the increased signal input level. Now, while observing the SINAD meter reading, slowly increase the deviation of the signal generator until the SINAD reading is degraded back to the 12dB SINAD level. At this point the deviation of the signal generator (±X kilohertz) is the modulation acceptance bandwidth.

For narrowband FM, the *minimum* modulation acceptance bandwidth figure should be ±5kHz. This figure is really not enough for fully modulated signals because the modulated signal occupies a greater bandwidth. Typical receivers usually are rated at about ±7kHz modulation acceptance bandwidth.

With modern crystal or ceramic filters, the bandwidth usually is on the low or narrow side if the input/output impedance matching adjustments are misadjusted.

A fair test?

The test procedure described above for modulation acceptance bandwidth sometimes can be misleading and can, in some cases, lead to an unfair rating of a receiver's specification figure for modulation acceptance bandwidth. Why?

The reason is that the input signal level varies according to the *measured* 12dB SINAD sensitivity of the receiver; that is, the input signal level for determining modulation acceptance bandwidth is 6dB greater than the reference sensitivity level of the receiver.

To make a truly valid comparison of the modulation acceptance bandwidth specification between two receivers of the same model (without regard to the reference sensitivity), it would only be fair to make the measurement at the same input signal level.

You probably have seen receivers that exhibit a much better 12dB SINAD sensitivity than the rated specification. For example, a receiver with a reference sensitivity rating of 0.35μV is tested and found to have a sensitivity of 0.25μV or even 0.20μV. This means that the modulation acceptance bandwidth test for that receiver is run with an input signal level of 0.5μV or 0.4μV (6dB above reference sensitivity).

Then, when the modulation acceptance bandwidth test is run at twice the measured sensitivity input level, the modulation acceptance bandwidth figure may fall short of the specification figure. In such cases, it is better to measure the modulation acceptance bandwidth at a signal input level 6dB above the manufacturer's *specification* figure for sensitivity rather than 6dB above the *measured* sensitivity level.

When using the modulation acceptance bandwidth test to determine the performance of a receiver or to compare the performance of two receivers, use common sense. Make the comparison on an equal basis. Run the test in the standard way and then run the modulation acceptance bandwidth test using the same input signal level and compare the two results. This will give you a better idea of the receivers' performance under like conditions.

Modulation spectrum

Although the frequency-modulated signal has sidebands extending out to theoretical infinity, it has been determined that

SIDEBAND POWER CALCULATIONS

(1) $P_T = J_0^2(\beta) + 2[J_1^2(\beta)] + \ldots 2[J_n^2(\beta)]$

(2) $P_{T_1} = (0.2601)^2 + 2[(0.3391)^2] + 2[(0.4861)^2] + 2[(0.3091)^2] + 2[(0.1320)^2] = 0.06765 + 0.23 + 0.4726 + 0.1911 + 0.0348 = 0.99615 = 99.6\%$

(3) $P_{T_2} = (0.1776)^2 + 2[(0.3276)^2] + 2[(0.04657)^2] + 2[(0.3648)^2] + 2[(0.3912)^2] + 2[(0.2611)^2] + 2[(0.1310)^2] = 0.0315 + 0.2146 + 0.00434 + 0.2662 + 0.3060 + 0.1363 + 0.03432 = 0.99326 = 99.3\%$

(4) $P_{T_3} = (0.3001)^2 + 2[(0.004863)^2] + [(0.3014)^2] + 2[(0.1676)^2] + 2[(0.1578)^2] + 2[(0.3479)^2] + 2[(0.3392)^2] + 2[(0.2336)^2] + 2[(0.1280)^2] = 0.0900 + 0.000047 + 0.1817 + 0.0562 + 0.0498 + 0.2421 + 0.2301 + 0.1091 + 0.0328 = 0.9918 = 99.2\%$

sidebands containing 98% of the power in the modulated signal are confined to a relatively narrow bandwidth. Furthermore, if the sidebands containing at least 98% of the signal power are passed through the receiver, the signal can be reproduced with little distortion.

Figures 2, 3, and 4 on page 8 show the modulation sideband spectra of a signal frequency modulated by a 1kHz single tone at deviations of ±3kHz, ±5kHz and ±7kHz, respectively. This represents a modulation index (β) of 3 for Figure 2; 5 for Figure 3; and 7 for Figure 4. Table 1 on page 8 shows the Bessel function for the carrier and sidebands for each of the modulation sideband spectra.

The carrier and sideband pairs in Figure 2 contain 99.6% of the total power in the frequency-modulated signal. The carrier and sideband pairs in Figure 3 contain 99.3% of the total power, and the carrier and sideband pairs in Figure 4 contain 99.2% of the total power. The percentage of power contained in the sideband pairs and carrier is calculated as shown in the box to the left. The generalized expression for the formula is shown in Equation 1 in the box. Equation 2 represents the

calculation of total power in the sideband spectrum shown in Figure 2; Equation 3 is for Figure 3; and Equation 4 is for Figure 4.

Required bandwidth

The bandwidth required to pass the modulated sideband spectra shown in Figures 2 through 4 can be calculated from the following formula:

$$B_W = 2f_M(\beta + 1)$$

where

B_W = bandwidth in kHz

f_M = modulating frequency in kHz

β = modulation index

Modulation index (β) = deviation ÷ modulating tone frequency.

You can see that the formula for bandwidth holds true for the sideband spectra shown in Figures 2, 3 and 4. For example, in Figure 2 the modulation index is 3 (3kHz deviation and 1kHz tone). Substituting into the formula:

$$B_W = (2)(1)(3 + 1) = 8$$

Thus, the bandwidth is 8kHz. In Figure 2, the significant sidebands extend to ±4kHz, which corresponds to a bandwidth of 8kHz. This relationship can be verified in like manner for the sideband spectra shown in Figures 3 and 4.

These illustrations show why the required bandwidth is more than just the amount of deviation of the signal. If at least 98% of the power in the modulated spectrum is passed by the receiver, the audio modulation can be reproduced with little distortion. However, when *significant* sidebands fall outside the bandpass of the receiver, distortion results. This phenomenon is why the modulation acceptance bandwidth specification of a receiver is so important.

That being the case, it is equally important to be able to compare the performance features of two receivers fairly in making a true performance determination. Thus, it is very useful to run the modulation acceptance bandwidth test at equal signal input levels.

Stay tuned!

Freedom of association

By Robert H. Schwaninger Jr.

On Oct. 26, 1994, the Personal Communications Industry Association (PCIA) announced that its merger with the National Association of Business and Educational Radio (NABER) has become official, following membership approval. NABER president E.B. "Jay" Kitchen has become president of PCIA.

Seen as an attempt to revive PCIA (formerly known as Telocator), the combination of NABER's cash flow and PCIA's commercial representation appears to be a good match.

However, questions persist about the marriage of these associations. The most obvious is Who will be represented by the new PCIA?

Throughout its existence, NABER held itself out as representing the traditional private radio licensee and private radio commercial operators. Its constituency was, ostensibly, thousands of tow truck operators, schools, churches, small commercial operators, hospitals, local paging providers, community repeater operators and the companies, groups, associations and people who relied on local radio service. A close analysis of PCIA's seven new membership sections does not indicate any room for these traditional NABER members.

The new sections are *paging and narrowband PCS, broadband PCS, SMR, wireless system integrators, technicians, site owners and managers*, and finally, *users*. In the parlance of the industry, a *user* is a consumer of services—a customer—not a licensee. So, one needs to look no farther than the make-up of the membership sections to see that schools, hospitals and churches have lost their infrequent spokesman, NABER.

Let me make one point clear: *NABER no longer exists*. It is important that this fact be fully appreciated to understand the merger's effect. The most obvious effect is that many entities that used to be represented by a defunct association known as NABER are no longer represented by PCIA or anyone else.

Frequency coordination

When the FCC certified associations and

Schwaninger, *MRT*'s regulatory consultant, is a partner in the law firm of Brown and Schwaninger, Washington, DC. He is a member of the Radio Club of America.

groups as frequency-coordination entities, the primary factor in its decision was each group's representation of the eligible radio operators. It was not by chance that, for example, the American Trucking Association was certified to coordinate spectrum for Land Transportation Radio Service eligibles. NABER claimed to represent the core of Business Radio Service eligibles and, therefore, was given its certification.

But with the PCIA merger and the formation of the membership sections, it appears that the traditional Business Radio Service eligible entity does not fit into PCIA's plans. Nowhere in PCIA's new structure is a group or committee that represents hospitals, schools or even large industrial licensees. In fact, the old stalwart of the industry, the community repeater operator, has no representation in PCIA's structure.

Without evidence that PCIA will represent traditional Business Radio Service eligibles, it appears that PCIA is willing to forfeit any right to perform frequency coordination . . .

PCIA's structure, following the merger, is a sign of the times. The telecommunications industry no longer is divided simply among radio services. It has become a caste system, where large, multibillion-dollar companies forward one agenda and small, local operators forward a different vision.

As is its clear right, PCIA has chosen to speak for the largest commercial telecommunications companies, and no one should find fault or argue with PCIA's honest choice. However, in making its choice, it is clear that PCIA has created a vacuum. This merger has left behind no voice for the smaller operators. There is certainly no effort to represent non-commercial Business Radio Service eligibles, such as hospitals and schools.

PCIA's choice—to go for the bigger dues-paying members—also calls into question PCIA's reliance on NABER dollars from frequency coordination. Without evidence that PCIA will represent traditional Business Radio Service eligibles, it appears that PCIA is willing to forfeit any right to perform frequency coordination, the certification for which is wholly dependent on "representativeness."

I predict that by the time this article reaches print, a rulemaking petition will be filed asking the FCC to initiate a selection process to name a new Business Radio Service frequency coordinator. I further predict that if no other entity files this rulemaking petition, I will.

Certified frequency coordination entities have never been given the authority to assign or transfer their certification. In fact, such authority would be contrary to the FCC's stated justification in granting certifications in the first place. Therefore, the FCC must solicit offers and public comment on the certification of the next entity to serve as a frequency coordinator to avoid confusion and to ensure that the job will be performed by a de jure and not simply a de facto coordinator.

The chasm of change

My comments should not be considered critical of PCIA. I wish its members well. The merger of the two associations will provide highly skilled representation for the largest telecommunications entities backed by greater resources than those previously enjoyed by PCIA. My concern is for those entities that will not enjoy the benefits of the merger and that are lost in the shuffle.

The smaller operators and the thousands of businesses that depend on affordable and accessible equipment, radio frequency spectrum and opportunity need a champion—a dynamic association that will serve their interests and agenda. This association should not be based solely on Radio Service, FCC Bureau, or commercial designations. It could include public safety entities and local governments, too. This association would simply be based on the only true designation left, *money*.

With the dawn of radio frequency spectrum auctions, the line between the "haves" and the "have nots" is drawn, creating a schism between the largest, richest telecommunications companies and the local entrepreneurs. This break inevitably will widen into a chasm, dividing the issues and desires of each increasingly separate group. It is clear that PCIA has chosen which side it will represent in the future: the richest members of the industry. It is my fervent hope that an equally adept and skilled representative emerges for the other side.

News

Motorola, E.F. Johnson sign joint licensing agreement

Motorola's Land Mobile Products Sector, Schaumburg, IL, and E.F. Johnson, Burnsville, MN, have signed a joint licensing agreement for digital radio technology used in public safety and other markets worldwide.

The agreement gives E.F. Johnson technology rights to Motorola's Astro and APCO Project 25 digital radio products. This includes hardware and software technology for mobile and portable radios, infrastructure and systems, including trunking. The two companies will make use of this common digital technology to develop future digital products, ensuring interoperability of Astro and Digital Multi-Net II.

The two manufacturers agreed to cross-license technology used in certain existing analog protocols. This cross-license allows them to develop digital products compatible with each other's analog systems to provide for backward compatibility and ease of migration to the new digital technology.

Southwestern Bell picks Motorola's PPS-2000 equipment for system trial

Motorola, Schaumburg, IL, and Southwestern Bell Telephone Company, St. Louis, will use Motorola's PPS-2000 equipment in a wireless local loop trial. The trial will be conducted in the St. Louis area and will focus on the wireless loop application of the system in which access to the public switched telephone network is provided by a radio link to the customer's home. With the installation of wireless fixed access units, subscribers can continue to use existing telephones, answering machines, fax machines and modems while having voice quality and service on a wireless system comparable to existing wireline service. This system will allow migration to mobile PCS services in the future.

Magellan ranks 68th on *Inc.* magazine's fastest growing company list

Magellan Systems, San Dimas, CA, is ranked 68th in *Inc.* magazine's annual listing of the 500 fastest-growing private companies in America. To be selected for the 1994 *Inc.* 500, a company must have been independent and privately held through the 1993 fiscal year; it must have recorded at least $100,000 in 1989 sales, but no more than $25 million; and it must have shown a sales increase between 1992 and 1993. Rankings are determined as a function of a percentage of sales growth during the period 1989-1993.

Magellan shipped its first GPS receiver product in 1989 and has sold more than 200,000 GPS receivers and systems since that time. International sales account for 45% of revenue.

Geotek activates FHMA digital network in Philadelphia

Geotek Communications, Montvale, NJ, has begun operating its new frequency-hopping multiple access (FHMA) digital voice and data network in Philadelphia. FHMA will allow Geotek to construct a wireless network with fewer cell sites than competing technologies, making infrastructure costs much lower than those of other wireless architectures, said Dr. Purnendu Chatterjee of the Soros group.

The Soros investment partnership signed a definitive agreement to purchase an additional $10 million in preferred shares, increasing its total investment in the company to $50 million.

Celwave expands total system engineering services

Celwave, Marlboro, NJ, has established Celwave Distributed Communications Systems (DCS), Phoenix, AZ, in response to an increasing number of customer requests for value-added engineering. Once the customer defines the problem and sets desired performance levels, Celwave DCS can redesign the current system, design a new one, specify all equipment, install it, conduct testing, provide documentation and train customer personnel until they are comfortably proficient in the system's operation.

Wavetek acquires Schlumberger Communications Test division

Wavetek, San Diego, CA, has acquired the Communications Test Division of Schlumberger Technologies. The Schlumberger sales and support team has moved to Burlington, MA. The new address and phone number is Wavetek, 128 Wheeler Road, Burlington, MA, 01803; 617-229-7585; 800-392-8100; Fax 617-273-5943.

Readers' choice

Of all the new products and services in the May 1994 issue, the one reprinted here generated the most reader requests for additional information. If you missed it the first time, here is your opportunity to acquire more information on it. Just circle the corresponding Fast Fact Card number on the card found in the back of this issue and mail the card to us.

Wireless communicator provides personal info, data management

The **Motorola** Envoy personal, hand-held, wireless communicator provides two-way, wireless, wireline and infrared communications. The unit, which was released in the summer of 1994, uses Motorola's 1/68349, 32-bit, 16MHz microprocessor. The Envoy communicates with electronic mail systems, Windows-based computers, Macintosh computers, fax machines and other Envoy communicators. A built-in, two-way wireless packet data modem provides access to AT&T PersonaLink Services and RadioMail over the Ardis network. Integrated hardware includes two PCMCIA Type II slots, a 480 × 320 resolution LCD touchscreen operated by stylus or finger touch, a smart peripheral port, rechargeable NiCd battery, owner identification security circuitry, 1MB of RAM and 4MB of ROM. Information can be input with an on-screen keyboard or with a stylus. In addition to numerous built-in personal management tools, 15 third-party software applications and services are available. The 1.7-pound communicator measures 7.5"W × 5.7"H × 1.2"D.

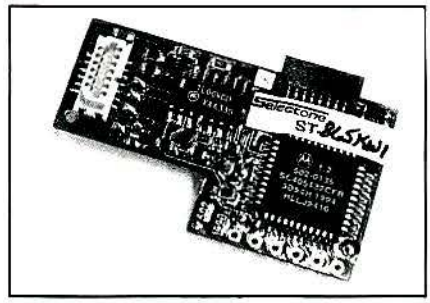
Circle (500) on Fast Fact Card

Hand-helds feature 24 channels, user-programmable panel switches

Two commercial hand-held transceivers from **Icom America** allow as many as 10 programmable functions to be accessed from the front or top panel switches. The IC-F10 VHF model covers frequencies from 136MHz–150MHz or 146MHz–174MHz. The UHF version, the IC-F20, covers 400MHz–430MHz, 440MHz–470MHz or 490MHz–520MHz. Both units have eight-character, alphanumeric LCDs for displaying channel and function information. The 24-channel hand-helds offer two selectable scan lists with three types of scans. Signaling systems include CTCSS standard, with DTCSS, two-tone and five-tone capabilities optional. Automatic ID transmission is also available as an option.

Circle (351) on Fast Fact Card

Digital logic boards for trunking retrofit Standard, Kenwood radios



Mobile logic boards for digital trunking with portable transceivers are available from **Selectone**. The ST-865S2 SmarTrunk II board is for the Standard HX240/241/260 and 260MarkII portable transceivers. The ST-865KW1 SmarTrunk II board is for the Kenwood TK-248/348/248ST/348ST portables. The digital signaling format operating modes include radiotelephone trunking, fleet dispatch trunking and conventional operation.

Circle (352) on Fast Fact Card

Programmable 10-channel hand-held includes adapter/trickle charger

The T-80 hand-held from **Tekk** is a 5W, 10-channel, VHF synthesized wideband radio with channel separation across the entire 150MHz–172MHz bandwidth. It features programmable scan, priority scan, CTCSS/DCS, internal vox and four battery save settings. The standard battery is a 1,200mAh NiCd, and a wall adapter/trickle charger is included. The T-80 is PC-programmable for all frequency, scan and signaling features on a per-channel basis.

Circle (353) on Fast Fact Card

New products

Public safety market hand-held features alphanumeric channel ID

Standard Communication's HX-440 series hand-held for the public safety market has a wideband 200-channel capability. Transmission power is selectable at 5W or 2W. The radio's alphanumeric channel ID allows the user to assign a three-character alphanumeric designator to each channel, which is displayed on a backlit LCD. Built-in features include all 37 EIA CTCSS tones along with DTMF encode, DCS and ANI capabilities. Also included are a periodic sleep mode, time-out timer and busy-channel lockout.

Circle (354) on Fast Fact Card

Mounting hardware positions mobile laptops for convenience

SMC-Electro-Mount mounting hardware for mobile installation of laptop or notebook computers adapts to most models. The computer is attached and removed by use of an integrated key lock.

Circle (355) on Fast Fact Card

Upgrade for hand-helds includes dual display for transmit, receive

Monark International has upgraded its miniature CR-1656-V and CR-1658-U hand-helds with a new dual LCD that shows both the transmit channel and receive channel numbers simultaneously. During the scan mode, the receive channel indicator changes, but the transmit channel indicator displays the last channel selected by the rotary selector switch. The 16-channel radios have 5W RF output in VHF or UHF and feature 16-channel CTCSS encode/decode, DTMF encode and decode, time-out timer and busy-channel lockout.

Circle (356) on Fast Fact Card

Pagers offer increased memory, display options, greater sensitivity

The "Evertell" four-line alphanumeric pager allows the user to select one of three message font sizes for display. Memory capacity accommodates about 120 name and telephone records. The design of the synthesized "Everlink" pager is intended to provide greater sensitivity than general crystal numeric pagers. Special "Everlink" functions include theft lock, batch message reception and switchable tones. The pagers are available from **Everon Mobilcom.**

Circle (357) on Fast Fact Card

Connector allows hand-held phone to be used with external antenna

Mobile Mark's coupler-connection allows the Motorola Classic cellular phone to be connected directly to an external car antenna. Special adapters attached to the phone and stub antenna allow the user to pull off the phone's antenna and push on the special electro-coupler. The connector works with all Motorola Classic, Motorola 8000/9000 and Pulsar phones.

Circle (358) on Fast Fact Card

Key chain pager identifies pages with audible alert, LED patterns

The Calypso DE306 POCSAG-format key chain pager from **Miracom Technologies** weighs 1.7 ounces and measures 2" × 1.2" × 0.6". Four available subaddresses for new message signaling are identified by distinct LED blinking patterns. A slide control adjusts loud/silent volume. The pager uses a standard AAA battery. Frequency ranges are 138MHz–174MHz VHF and 390MHz–470MHz UHF.

Circle (359) on Fast Fact Card

High-power miniature transceivers expand business-use hand-held line

The Courier Procom M510 VHF transceiver and MU510 UHF transceiver from **Fanon Courier** are both 5W miniature, 10-channel, hand-helds. The M510 model is preprogrammed with five frequencies and operates on land mobile VHF band frequencies from 148MHz to 174MHz. The MU510 is preprogrammed with eight frequencies and operates on general mobile radio service and business band radio service UHF band frequencies from 450MHz to 470MHz. Features include digital channel readout, squelch control and channel scan. The units weigh 15 ounces and measure 4½"H × 2 1/16"W × 1⅜"D.

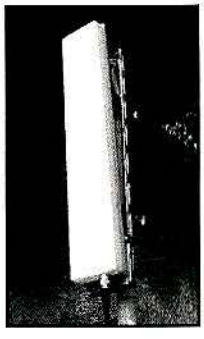
Circle (360) on Fast Fact Card

Router, concentrator provide options for management of paging systems

Hark Systems' PC-based Telocator Network Paging Protocol (TNPP) router allows routing programming on one computer menu screen. Real-time monitoring and statistics are standard. Selected packets can be logged for diagnostics or reporting. When used in conjunction with a Hark TAP200 or PC Tap Controller, the TNPP router can convert TNPP to Telocator Alphanumeric Protocol (TAP) and TAP to TNPP. Hark's PC Tap Controller is a PC-based alphanumeric concentrator that can connect 48 telephone lines to one high-speed computer port on most paging terminals. The input ports can operate at high baud rates, including 38,400 baud. The PC Tap Controller also can be used to remotely connect alphanumeric traffic via dedicated lines and dial-up connections.

Circle (361) on Fast Fact Card

Panel antennas for PCS networks provide selection of coverage, gains



The QuintStar PCS panel antennas from **Dapa Communications** are designed for 1.71GHz to 1.99GHz wireless personal communications services (PCS) networks. Horizontal coverage patterns include 60°, 90°, 105° and 120°, with gains ranging from 7.0dBd to 17.9dBd. Each of the 20 available panel models can be specified with electrical downtilt at no additional charge. A mechanical tilt kit is available as an option.

Circle (362) on Fast Fact Card

In-building paging transmitter contains built-in AFSK demodulator

The RF Neulink DPT/DPFT digital paging transmitter from **RF Industries** is designed for in-building applications such as hospitals, factories, security systems, parking structures and basements. The transmitter is also available with a built-in AFSK (1,200 baud or 2,400 baud) demodulator for connection to existing 72MHz receiver links.

Circle (363) on Fast Fact Card

Product/services directory

For more information on the products and services offered by the following advertisers in this issue, circle the corresponding number on the Fast Fact Card found on page 77.

Allen Telecom Group

Allen Telecom Group produces base station equipment, including amplifiers, antenna systems, duplexers and multiplexers; signal coverage expanders, including boosters, microcell systems and repeaters; wireless measurement instruments; land mobile and cellular antennas; and systems integration.

Circle (451) on Fast Fact Card

Celwave

Celwave offers nine bi-directional amplifiers designed to solve in-building communications problems. They have automatic gain control circuitry to prevent oscillation damage and intermodulation distortion. FCC type accepted and DOC certified for operation in 800MHz and 900MHz SMR/public safety bands.

Circle (452) on Fast Fact Card

Combined Technologies

Combined Technologies manufactures remote display and control equipment for receiver voting systems. It also makes transmitter steering controllers that work with comparators (voters) to steer multiple transmitters.

Circle (453) on Fast Fact Card

Communications Specialists

Tone signaling equipment for two-way radio systems, including paging encoders/decoders, repeater tone panels, DTMF, CTCSS, DCS retrofit devices, Morse station IDers, and video transmission equipment.

Circle (454) on Fast Fact Card

Connect Systems

Connect System's model CS-900 vox-controlled, simplex interconnect eliminates costly leased lines and dc remotes. Access your base radio from any telephone, anywhere.

Circle (455) on Fast Fact Card

D&L Communications

The Slowpoke On/Off Timer has many uses. Its primary function is the prevention of dead batteries due to a mobile radio, cellular phone or other in-vehicle device being left on for extended periods of time when the vehicle is left unattended.

Circle (456) on Fast Fact Card

Doppler Systems

Doppler Systems offers a line of reasonably priced direction-finding systems covering 50MHz–1,000MHz. Users include cellular companies, two-way commercial radio networks and government agencies.

Circle (457) on Fast Fact Card

Douglas Integrated Software

ComSitePlus software offers an integrated wireless communications site interference analysis program that evaluates transmitter noise, receiver desense and intermodulation signal level analysis. It automates site design and management.

Circle (458) on Fast Fact Card

ElectroCom Communication Systems

The diversity reception controller uses a multi-receiver technique and is designed to reduce the destructive effects of multipath fading, resulting in dramatic improvements in RF reliability and coverage.

Circle (459) on Fast Fact Card

Hutton Communications

Wireless communications equipment and components from Hutton! As a regional distributor with national strength, Hutton can offer fast delivery, personal service and product delivery.

Circle (460) on Fast Fact Card

IFR Systems

IFR Systems designs, manufactures and markets communications service monitors, RF and microwave spectrum analyzers and avionics test equipment. Through its wholly owned subsidiary, Photon Kinetics, the company also provides test equipment for the manufacture, installation and maintenance of fiber-optic systems.

Circle (461) on Fast Fact Card

JBro Batteries

JBro Batteries manufactures replacement batteries for a wide variety of land mobile radio communications equipment. Since 1976, JBro has endeavored to earn a reputation for product innovation, uncompromising quality control and design expertise.

Circle (462) on Fast Fact Card

JPS Communications

JPS manufactures communications peripheral equipment for mobile radio systems. JPS' SNV-4 votes using an independent digital signal processor (DSP) on each channel to measure true signal-to-noise conditions.

Circle (463) on Fast Fact Card

Larsen Electronics

Larsen Electronics manufactures high-performance mobile, on-glass, portable and base station antennas. Larsen produces more than 1,000 antenna models from 27MHz to 2+GHz for the most demanding international, commercial and amateur applications.

Circle (464) on Fast Fact Card

Maxon America

FM two-way communications equipment offered by Maxon includes synthesized VHF and UHF portable and mobile radios and crystal portable radios for VHF lowband, VHF highband and UHF. POCSAG numeric pagers, paging systems, data telemetry modules and SMR/trunking radios also are available.

Circle (465) on Fast Fact Card

Modular Communication Systems

Modular Communication Systems consoles and stand-alone dispatcher workstations are designed for today's emergency communications requirements. The Ultra-Com PRO features Screenmaker and Customizer programs, allowing the user to design screens to fit specific operating requirements.

Circle (466) on Fast Fact Card

Motorola Test Equipment Products

Motorola Test Equipment Products produces communications systems analyzers that combine the functionality of many different pieces of test equipment into a single, compact, portable unit to test two-way radios, pagers, cellular telephones and cellular base sites.

Circle (467) on Fast Fact Card

MX-COM

MX-COM provides privacy and high-security analog scrambling for two-way radio applications. Tone-signaling products provide fast unit identity (ANI) plus expanded safety features for fleet operations.

Circle (468) on Fast Fact Card

Newtronics Antenna

The new Spirit series of vertical antennas are available to cover frequency bands from 40MHz to 2.6GHz in a variety of gain configurations.

Circle (469) on Fast Fact Card

Orbacom Systems

Orbacom Systems manufactures conventional and trunked radio dispatch consoles for all sizes of systems. System design as well as ANSI- and ADA-compliant space planning is provided.

Circle (470) on Fast Fact Card

PiRod

PiRod's "Tower Parts and Accessories" catalog is loaded with photos, drawings and descriptions to help you identify, specify and price the tower parts you need.

Circle (471) on Fast Fact Card

PolyPhaser

PolyPhaser designs and manufactures more than 2,500 models of lightning, grounding and electromagnetic pulse (EMP) protection products. Consulting services and seminars are available.

Circle (472) on Fast Fact Card

ServiceWare

Over 800 service organizations have implemented ServicePlus. ServiceWare's latest product—ServicePlus Series 2—offers integrated logbook (work orders/invoicing), inventory control, service contracts, purchase order, dispatch modules and interfaces to ACCPAC plus, Great Plains and SBT accounting systems.

Circle (473) on Fast Fact Card

Shinwa Communications of America

Shinwa Communications manufactures tone and voice pagers along with a new numeric pager and a high-spec portable and mobile radio.

Circle (474) on Fast Fact Card

Shure Brothers

The system approach to land mobile. Shure's ModuLink System 1 offers five quality microphones with modular cordsets that quickly connect to most radio transceivers with no hardwiring.

Circle (475) on Fast Fact Card

SMC Electro-Mount

SMC Electro-Mount designs, manufactures and markets installation systems for all types of mobile communications equipment, including cellular phones, two-way radios, MDTs and laptop computers.

Circle (476) on Fast Fact Card

Solar Electric Specialties

Wholesale distributor and manufacturer of solar electric power systems for remote telecommunication applications. Featuring MAPPS, BETRSolar and Photogenset complete stand-alone and hybrid power system packages.

Circle (477) on Fast Fact Card

Standard Communications

Standard Communications' 15W GX5810T is a compact, data-ready trunking mobile delivering dual protocol technology, 800MHz operation with talkaround, easy telephone interconnect and password protection.

Circle (478) on Fast Fact Card

Survey Technologies

The STI-9000 test system automates drive test measurement, analysis and report of RF signal coverage for new site setup, verification and system maintenance.

Circle (479) on Fast Fact Card

Wavetek

The 4032 Stabilock supports all of the known digital cellular formats. It will test TDMA, GSM, JDC at 800MHz and 1.5GHz mobiles and base, CDMA mobiles and base and CS-1800 at 1.8GHz.

Circle (480) on Fast Fact Card

Wacom Products

Wacom manufactures coaxial cavity filters, duplexers, transmitter combiners and receiver multicoupler systems operating in the 30MHz to 960MHz bands.

Circle (481) on Fast Fact Card

Refer to the Advertisers Index on page 76 for the page reference to the company's advertisement

Literature

Catalog describes semiconductor products

A short-form catalog from **Loral Microwave-FSI** describes new PIN diodes, tuning varactors and Shottky devices. Complete specifications, including outline drawings and performance charts, are provided for more than 65 semiconductor catalog products.

Circle (300) on Fast Fact Card

Pricebook features site equipment

A 272-page pricebook from **Communications Associates** lists more than 50 LMR, SMR, paging and site equipment product lines for quick reference. Part numbers, product descriptions and pricing are organized in an easy-to-use format.

Circle (301) on Fast Fact Card

Guide features coaxial cables

A selection guide of coaxial cables for RF and microwave interconnections within equipment boxes is available from **Times Microwave Systems**. The range of small semi-rigid and flexible cables of various constructions are evaluated to allow the selection of the best cable for the application. Characteristics included are shielding efficiency, attenuation, peak and average power handling, temperature rating, phase stability, phase noise, passive intermodulation distortion and environmental resistance. In addition to providing information on the full range of MIL-17 cables, the brochure includes information on T-Flex, LMR, Stripflex and low-loss expanded PTFE proprietary products.

Circle (302) on Fast Fact Card

Catalog contains 45,000 product selections

A 276-page industrial electronic components catalog provides specification drawings and up-to-date prices. The catalog from **Mouser Electronics** contains more than 45,000 in-stock, factory-authorized products from more than 100 manufacturers and contains new product listings from AMP, Teccor, SGS Thomson, Littelfuse, Amphenol, 3M and Belden. A quick index on the front cover and a comprehensive index of both manufacturers and product categories make the catalog easy to use.

Circle (303) on Fast Fact Card

Handbook provides information on wireless spectrum

The Spectrum Regulation Handbook from **Thompson Publishing Group** provides information on auctions, construction permits, renewals and frequency allocation. The handbook explains the spectrum requirements for wireless communications, including personal communications service, cellular radio, specialized mobile radio, operational fixed microwave, multiple address systems and paging.

Circle (304) on Fast Fact Card

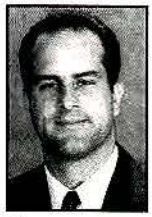
Booklet, seminar detail mobile cellular antennas

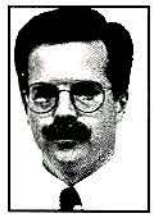
An educational seminar and accompanying booklet covering mobile cellular antennas is available from the **A/S Mobile Division** of **Allen Telecom Group.** The seminar and booklet, called *Air Time*, are designed for carriers and installers and explain the different mounting types and locations, as well as the various technological considerations involved with selecting an antenna.

Circle (305) on Fast Fact Card

People


Mazur


Bleeker


Brophy


Kepple


Fritz


Friedberg

Douglas A. Mazur, executive vice president of both TeleLink Technologies, Vancouver, British Columbia, Canada and FirstTel Communications, Vancouver, moves up to president and director of TeleLink Technologies, a wholly owned subsidiary of TeleLink Communications (TCC), Vancouver.

Russell Bleeker leaves Sanyo Energy (USA) as district sales manager to join Centurion International, Lincoln, NE, as sales manager for battery products.

John Brophy Jr., vice president of corporate operations for JBro Batteries, Lisle, IL, advances to executive vice president.

Members of the Specialized Mobile Radio Wireless Operators Network (SMR WON), Greenwood, MS, a new trade association formed to represent small SMR system operators, elected officers and directors on Nov. 10.

President: **Dave Savolainen,** Range Communications, Marquette, MI; *vice president,* **Bill Wyatt,** Total Comm, Enid, OK; *secretary,* **Walter Gallinghouse,** Communications Center, Covington, LA; *treasurer,* **Harold O'Dell,** Leflore Communications, Greenwood, MS. Directors include **David Chadwick,** Chadmoore Communications, Las Vegas; **Glenn Clark,** Clark Communications, Lewiston, ID; **Bill Holsworth,** Business Radio, Kennewick, WA; **Galen McCord,** Minnesota Wireless, Minneapolis; **Bob Roberts,** P.E.C. Mobile Communications, Springfield, IL; and **Gene Stoker,** Idaho Communications, Boise, ID.

Floyd L. English, president of Andrew, Orland Park, IL, adds to his responsibilities by becoming chairman of the board of directors.

Robert J. Leacock leaves LeBlanc Royal, Oakville, Ontario, Canada, as a manager for subcontracting and field services to join Broadcast Communications, New Glarus, WI, as applied engineering and construction divisional manager.

Hugh McDonald departs Automatic Data Processing, Houston, as national account manager to join SMC Electro-Mount, Tomball, TX, to direct sales into the public safety, special emergency and utility markets.

David Montanaro exits Motorola Satellite Communications, Chandler, AZ, where he was responsible for the manufacturing strategy and organization to produce space vehicles for the company's Iridium project, to join Teledesic, Kirkland, WA, as director of production technology.

George Hebner ceases doing business as president of All American North, Southport, CT, to join Telex Communications, Minneapolis, as a land mobile radio sales representative for the eastern United States. He will work out of Southport, CT.

Changes at Allen Telecom Group (ATG), Cleveland:

John Kepple, president of the Allen Test Products division, Kalamazoo, MI, advances to executive vice president of ATG.

Patty Fritz, distribution sales manager, advances to national distribution sales manager for ATG in Cleveland.

Randall Friedberg, vice president of sales for db Mobile, Dallas, moves up to national distribution sales manager for ATG in Dallas.

Sam Ginn, chairman of AirTouch Communications, receives The Commonwealth Club of California's 1994 Distinguished Citizen Award, given annually to recognize business and civic leaders who contribute to educational and charitable causes.

J. Andrew McGovern exits Dataworld as a software engineer to become a senior programmer at Communications Data Services, Falls Church, VA.

Jimmy Tucker, a founder and former president of CTI, Corinth, MS, establishes his own export and import marketing and consulting company, UltraTek, in Corinth.

Changes at Transcrypt International, Lincoln, NE:

Debra Nesbitt leaves Rivendell, Seward, NE, as director of human resources to join Transcrypt as director of human resources.

Arden Bock exits Signode, West Union, IA, as materials analyst to become purchasing administrator for Transcrypt.

Lara Collins, graduate of the University of Nebraska-Lincoln, joins Transcrypt as marketing services coordinator.

Mat Collins, machine supervisor, advances to manager of order processing and customer service.

Doug Ostergard, installation technician, moves up to telemarketing sales.

Ronald Kabler, vice president of engineering, adds to his responsibilities by becoming managing director for the strategic business unit (SBU) program.

Thierry Guichon exits Transworld, Escondido, CA, as project engineer to join Transcrypt as engineering group leader for the radio program.

Bill Shuman departs Motorola GPID, Fort Worth, TX, as a senior engineer to become an engineer with Transcrypt.

Steve Newman leaves BK Radio, Lawrence, KS, as a development engineer to join Transcrypt as an engineer.

Rob Burge exits Motorola GSTG, Scottsdale, AZ, as a senior electrical engineer to become an engineer in the Radio SBU program.

Mark Nispel departs Motorola, Mt. Pleasant, IA, as a development engineer to become a part of the Radio SBU program at Transcrypt.

William F. Lanahan leaves Inacom, Omaha, NE, as president and general manager of the direct operations division to join RAM Mobile Data, Woodbridge, NJ, as president.

Mobile Radio Technology™

The journal of mobile communications technology

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Englewood, CO 80111
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Fax: 303-793-0454

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Joyce Bollegar, 913-967-1840, *Midwest region,*
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Fax: 913-967-1735
Chris Coughlin, *List Rental Services Representative*, 913-967-1928, Fax: 913-967-1897
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Overland Park, KS 66212-2215

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Employment

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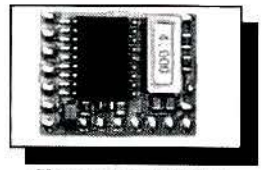

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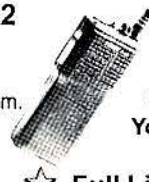

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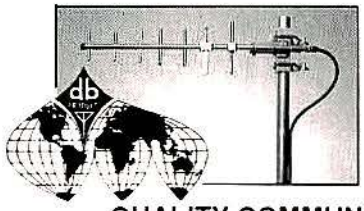

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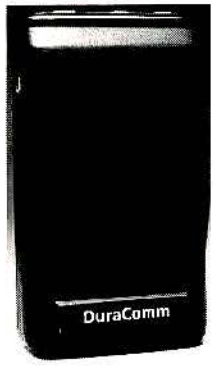

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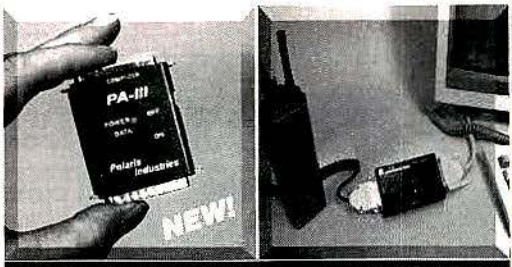

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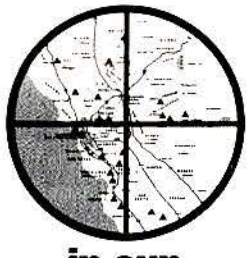

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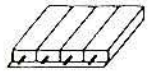

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Allen Telecom Group	IFC	1	216-349-8400
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Chargeguard Corp.	68	99	800-458-3410
Cimarron Technologies	25	22	800-487-7184
Combined Technologies Inc.	32	28	513-595-5900
Communication Instruments	61,72		303-962-9998
Communications Associates, Inc.	68	98	800-435-9313
Communications Data Services	71	101	800-441-0034
Communications Specialists	BC	3	800-854-0547
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CPI Communications, Inc.	47	46	214-437-5320
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Cushcraft/Signals Corp.	13	11	800-258-3860
Diablo Communications, Inc.	74	110	510-236-3700
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Douglas Integrated Software	48	48	904-656-8673
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IFR Systems, Inc.	31	27	316-522-4981
JBRO Batteries Inc.	41	39	800-323-3779
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Microflect	33	30	503-363-9267
Midian Electronics, Inc.	9	8	602-884-7981
Modular Communication Systems	16	14	818-764-1333
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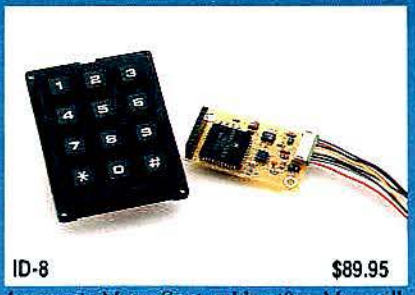

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Automatic Morse Station Identifier. Meets all FCC ID Requirements. Fully field programmable with included keypad. 1.85" x 1.12" x .35"

TE-64 $79.95

Self-contained Encoder, Rotary Dial Selection. Great for the Benchtop. 5.25" x 3.3" x 1.7"

CC-1/CR-1 $49.95 each

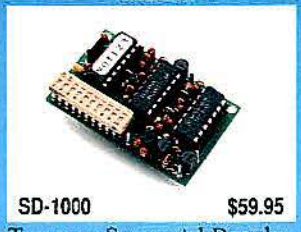
Surface Mount Component Kits for repairing SMT circuits. CC-1 for capacitors/CR-1 for resistors.

PE-1000 $224.95

Desktop Paging Encoder. Two-tone sequential, other formats available. 7.5" x 7.8" x 2.7"

PE-2P $54.95

Two-tone Sequential Encoder. Sub-assembly mounts inside radio or other enclosure. Multiple call capability. 1.25" x 2.0" x .4"



SD-1000 $59.95

Two-tone Sequential Decoder. Programmable unit provides switched outputs from two-tone paging calls. 1.25" x 2.0" x .4"

DTD-1 $59.95

Single Function DTMF Decoder. Provides switch outputs via DTMF. 1.25" x 2.0" x .4"

PE-4/PE-15 $99.95

Multiple Call POCSAG (RPC-1) Paging Encoders. Where direct control of local area paging is desired. 1.78" x 1.03" x .35"

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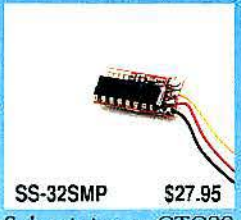
TS-32P $57.95

Programmable CTCSS Encoder-Decoder. Tone squelch for any FM transceiver. 1.25" x 2.0" x .4"

TS-64 $64.95

Sub-miniature Programmable CTCSS Encoder-Decoder. 1.7" x .78" x .25"



SS-32SMP $27.95

Sub-miniature CTCSS Encoder. Jumper programmable. .53" x 1.0" x .16"

SS-32PA $28.95

Programmable CTCSS Encoder. Custom tones or audible tones also available. .9" x 1.3" x .4"

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